

AMERICAN SOCIETY OF CIVIL ENGINEERS.

INSTITUTED 1852.

TRANSACTIONS.

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No. 796.

THE PROPER PROFILE FOR RESISTING WAVE ACTION.*

By ROBERT FLETCHER, Assoc. Am. Soc. C. E.

ABSTRACT.

In the correspondence contributed by the author to the paper† by Theodore Cooper, M. Am. Soc. C. E., entitled "Some General Notes on Ocean Waves and Wave Force," attention was drawn to the theory of waves advanced in 1831 by Col. A. R. Émy. The most novel feature of this theory assumes the existence under certain conditions of a bottom wave caused by the oscillatory waves nearer the surface. This bottom wave is a true wave of translation, which has little or nothing of an oscillatory character, and must exert horizontal energy nearly in proportion to its mass and the square of its horizontal velocity. The present paper is a continuation of the correspondence referred to, and discusses the best profile for resisting wave action.

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ject makes mention of the common failure at the foot of the works. This is often said to be caused by the "undertow," or the suction and downward motion of the water at the wall.

Rankine¹⁴ proposes to moderate the undermining action by forming the face of the wall into steps, "so as to interrupt the vertical descent of the waters." Stevenson's experiments on a stepped wall show that on such a profile the force of the waves may be increased six times. If such construction is sufficiently massive, with joints absolutely impenetrable by water or air, it may offer an efficient check; but with the usual imperfections in such work, it would appear that the wave of translation has simply more points of attack, and that the destruction of the lower courses is likely to be rather hastened than retarded.

Émy advocated a profile which shall present no sudden obstacle to the rapidly moving bottom wave, but shall deflect it from its horizontal movement, and compel it to expend its energy in raising itself and the superincumbent weight of water. While the cycloid was proposed as specially suitable, the form is not of chief importance, provided the curve is tangent to the bottom and of a radius sufficient to promote gradual deflection of the largest bottom waves.

Émy rebuilt the sea defences of St. Jean de Luz, at the head of the Bay of Biscay, by a long incline. A former expensive breakwater there, built of concrete and stone, with an average front slope of one vertical to three horizontal, and with a footing of heavy stones confined by piles just below low-tide level, was completely destroyed, chiefly on account of this provision. These rocks, some of which weighed $4\frac{1}{2}$ tons each, acted as missiles, impelled by the furious bottom waves, and made the destruction far more rapid and complete by a veritable bombardment.

The use of heavy material and steeper slopes is perhaps the most common way of opposing wave action. Rock is dumped into the sea and allowed to find its place. Admirably adapted to some localities, where large stone is plenty and where the wave energy is not great enough to move the stones, this system is generally used; but such works are often very expensive, require years of repairing before any degree of permanency is secured, and may be broken up again by the next great storm. The use of small stones in such cases invites failure. Half a century ago the Plymouth breakwater had changed its form

¹⁴ Rankine's "Civil Engineering," p. 761.

three times, and each time its base was extended and sectional area increased. At Cherbourg the same thing had happened, and the breakwater was said to have a base 350 ft. wide.

In some reports of the Corps of Engineers, U. S. Army, the question of foundation is dismissed with the statement that anything capable of bearing the weight of the upper part will do up to within 15 ft. of low water, because there is little action below that depth. This reasoning has led to the use of small material for the lower slope and to reserving the heavy blocks for the upper slope. The facts are that on most breakwaters built of *pierres perdues* not reaching far above sea level, the material from the seaward slope is carried over to the harbor side by the waves. For example, at Plymouth stones weighing from 3 to 8 tons each, firmly fixed in the pavement of the seaward slope, were torn up and projected over the breakwater into the sound.

At Delaware, before the completion of the breakwater, a stone weighing 7 tons was moved 18 ft. from the outside to the inside of the ice-breaker, and 200 tons of heavy stones, which had been well wedged together, were swept over to the inner side.

Vertical walls have been built on large mounds of stone, to prevent the passage of material from the outside to the inside, but it is evident that they may be subjected to heavy bombardment, and are never quite safe from settlement if the loose stones of the foundation are displaced. Émy designed walls with a curved face tangent to the bottom and having sufficient radius to deflect the largest waves.

Although these walls had existed but ten years at the date of his book on waves, they had proved much more durable than the old-style walls.

Émy was not the first to propose the curved front. Franz Gerstner, of Bohemia, had recommended it previously, and, later, English engineers have decided in favor of it, and the *Proceedings* of the Institution of Civil Engineers contain many discussions as to the merits of vertical, inclined and curved profiles.

For works designed primarily for other purposes than to hold the sea in check, as sea walls, lighthouses, etc., J. Scott Russell held the concave profile to be unquestionably the best form, for it approximates to the line of least resistance. Works rising above the surface of the sea, and designed to stop the waves so as to produce comparative calm, should exert a uniform action. To accomplish this,

he says: "The cycloid is the approximate form, and especially so when the materials are weak and not abundant." If there is a profile which will enable weak materials to do the work of strong, the question may well be raised whether it is good practice to use any other form.

Mr. Russell urged objections, of which a chief one is the fact that the water is forced up higher than is the case with a vertical wall, and that the parapet is more likely to be torn off, but this distinguishing feature would seem to be an advantage, for the force which raises the water would have been expended upon the wall itself. The parapet, if built smooth with no projections, will suffer no great impact, and may be curved slightly forward so as to throw the water seaward. Another objection is that the pressure is thrown higher up the wall, but it would seem that this is preferable to lower action on vertical walls, which destroys the foundation and causes the failure of a large part of the work.

Having referred to Mr. Russell as an advocate of the cycloidal profile, it must be said that he considered it useless and injurious for certain kinds of waves which he believed to exist. He thought that the rollers which occur at the Cape of Good Hope and other places, and the common ground swells, have a forward motion *en masse*, the whole depth of water rushing forward and then receding. This agrees with the observations of Sir John Coode at the harbor of Colombo, who stated that water is forced up 120 ft. above sea level by waves which are only 15 ft. high at the moment they strike the rock. He believed that during the occurrence of the heavy monsoon swell, it was the swell itself, not a broken sea, which came in with a great roll. On the other hand, these swells in mid-ocean do not have any perceptible motion of translation, but are taken as the true type of a wave undulation.

That these immense swells really entrain very large masses of water, is likely; if so, the bottom waves may become so large as to constitute the greater part of the whole wave, and, in shallow water, operate to impart to nearly the whole mass of the entire wave an energy horizontally directed. Mr. Russell would use a long reversed curve, concave above and convex below, to resist such action. The abrupt rise at the bottom would destroy much of the momentum of the bottom wave, but it would be subject to a large share of the shock that destroys the footing of vertical walls.

At Aberdeen the pier head was first constructed as a vertical wall in shoal water, but, "the foundations being insecure," it fell more than once from the "constant percussion of the undertow." "The cycloidal form was then adopted, by which a gradual resistance was offered to the force of the waves, and the head has stood for half a century" (reported in 1860).

Concave walls have been built near Edinburgh which have had varying success, and have been pointed to as throwing doubt on the practicability of that design. Nothing can be proved conclusively by them, because they were built of very light materials, and had other defective features. Still, compared with the massive vertical walls in the neighborhood, costing many times as much, they have done good service. The south pier at Whitehaven, built with a curved face and an apron of large stones founded upon sand, has resisted many great storms. Mr. Scott Russell cited this case as gratifying to him because of its success, although only an approximation to his recommended profile.

Lighthouse builders have made use of the concave profile because of its great stability, and, although not designed primarily to deflect waves of translation, the action at Eddystone and at other lighthouses shows fine examples of the manner in which it deflects and directs the energy of the waves vertically instead of allowing them to act horizontally against the structure.

Among modern French engineers the curved profile is not held in general favor. Some four years ago the author addressed an inquiry to M. Guillemain, Director of the National School of Bridges and Roads of France. The latter quoted the following opinion of M. Laroche, Engineer in Chief:

"Experience appears to justify curved fronts in a certain number of particular cases, and for special works exposed to less violent waves which have been broken by their passage over the incline of long submarine beaches of gentle slope; also, a curved front at the summit of slopes of shifting beaches for defence.

"Per contra, practice seems to have shown that for great jetties exposed to violent seas, the curved form of exterior front does not palliate the shock of the waves, at least during the continuance of real tempests.

"In fact, during a gale, the billows do not approach a jetty under the hypothetical conditions upon which some have reasoned. It is no longer a layer of water which glides upon the slope of the sub-

structure, as does the billow which exhausts itself upon a beach of gentle slope; it is an enormous mass of water, a veritable liquid hillock, of which the ridge, mounting above the sea, precipitates itself with a crash upon the work, and strikes almost at the same instant the whole height from the parapet to the top of the substructure. Under these conditions it is conceivable that a curvature of the front, a curve always rather slight at best, can have only a small influence upon the violence of the shock of the billow.

"Indeed, jetties with a curved front require, in order to insure the stability of the parapet, a cube of masonry quite as considerable as jetties with a straight front, and the billows surmount as well the former as the latter, while the tempest lasts. So that curved fronts appear to have advantages only in tractable weather, that is to say, when one can conveniently exempt one's self from having recourse to a disposition which leads always to costly requirements in execution.

"The theory of curved fronts requires quite a sharp angle at the base of the superstructure, so that the wave may reach it without shock, and this condition had been at first observed at St. Jean de Luz; but this thin part, lacking in solidity, was repeatedly broken and destroyed. It has become necessary to commence the curve immediately above the blocks of the substructure, and to give at the base of the superstructure a vertical front of 2 m. height.

"Finally, and within the limits which permit us to formulate an opinion of by no means general application upon questions so complex, so controverted, and where, moreover, local and special circumstances play so important a part, we can state that the form of the exterior front of the superstructure of a jetty is indifferent from the point of view of the resistance of the work during tempests. It is expedient, then, in most cases to adopt the more simple and more easily realized form, namely the plane front."

M. Guillemain adds: "The opinion of M. Laroche is that of the greater number of French engineers, and all breakwaters which have been recently built in France and in Algeria, with rare exceptions, have received plane fronts rather than curved."

It appears certain, however, that the curved profile has, by actual comparative trials, proved more efficient and permanent than the plane front in some situations; and that it should be used under those conditions which are favorable to its application. For example, on rock bottom at or not far below low-water level, the tangential junction of the curved toe with the rock may be properly made, and if the lowest courses are dowelled and clamped together and the joints of the entire front made water-tight as low down as possible, a much smaller cross-section would be required because of the relief from direct impact.

afforded by the deflecting curve where the waves are not too severe. Other favorable conditions and dispositions will be recognized by the experienced engineer.

It is hardly conceivable that there is any case where the body of the sea comes upon a work *en masse*, with a common horizontal velocity throughout, excepting that of the earthquake wave, which, fortunately, is not common, and which man should not expect to oppose successfully by any work which he has the means to build. This is a great sway, backward and forward, like that produced in a tub of water which is tilted. The tidal bore is not to be classed as a wave to be resisted by a breakwater.

The history of jetties and breakwaters is largely one of failures, costly and often repeated. Too much has been done in many places without a sufficient study of past experience, or an adequate idea of the enormous energy and the mode of action of storm waves. Witness on a very small scale the utterly inadequate means and methods of shore protection adopted at some seaside resorts, as Long Branch and Coney Island, where, if it is true that sufficient works would be too costly, it is no less true that there should be enough appreciation of the task to deter from such futile endeavors.

Nevertheless the judgment of the engineer must be largely guided by a knowledge of such failures, and it is to be regretted that the record of failures and damages to such works is not more complete, especially as relating to jetties and breakwaters on American coasts and lake ports.

The standard type of breakwater adopted by the Corps of Engineers, U. S. A., for the harbors of the Great Lakes is a timber crib of rectangular cross-section, filled with stone and resting usually on a broad base of random stone which the waves have compacted into a more or less stable profile. While generally doing good service for that type of construction, which is approved as usually the best within the means available for construction and maintenance, these works have not proved altogether satisfactory, having been repeatedly destroyed at certain points in various harbors. While the writer would not presume to make direct criticism of the system so long adhered to by distinguished engineers, he considers it a fair question whether the principle of the curved profile is not especially applicable in such exposures as are found on the Great Lakes. Cribwork has been and may

readily be built with a curved front and the face protected by planking below low water and as far above as desired. Such a mass is peculiarly subject to the disintegrating action of water pressure transmitted through all the interstices, and it would seem that the double-planked concave front would give such deflection to the storm wave as would greatly mitigate the shock.

Mr. W. R. Kinipple calls attention* to the great value of monolithic work of concrete for breakwaters. His experience of thirty years has convinced him that such construction, carried down even to the bed of foundation, and including all the substructure by a process of injection and "stock-ramming" of cement grout, embodies the true principle, by avoiding all the difficulties of joints, dowelling, clamping, dovetailing, and the inherent weakness of a substructure of separate fragments, where the conditions are especially suitable for destructive action of violent waves. He has successfully reconstructed and extended important works by this system, and claims greater efficiency, durability and less cost than for any form of jointed structure. It is needless to add that concrete is particularly well adapted to the execution of a curved profile.

* See *Engineering*, Vols. I and LIII.

MEMOIRS OF DECEASED MEMBERS.

ALEXANDER DALLAS BACHE, Hon. M. Am. Soc. C. E.*

DIED FEBRUARY 17TH, 1867.

Alexander Dallas Bache, born at Philadelphia, July 19th, 1806, was the grandson of Richard Bache, Postmaster-General of the United States from 1776 to 1782, and a great-grandson of Benjamin Franklin. He was educated in a Philadelphia school and at the United States Military Academy at West Point. He was graduated at the head of his class, one of unusual ability, from the latter institution in 1825, and remained there for one year as an assistant professor. Subsequently he was assigned to duty at Newport, R. I., under Colonel Joseph G. Totten, Hon. M. Am. Soc. C. E., and while there married Miss Nancy Clarke Fowler.

Leaving the army he went to Philadelphia as Professor of Natural Philosophy and Chemistry in the University of Pennsylvania, and then began a career as physicist and astronomer which soon brought him an international reputation. At that time the Franklin Institute had not been established very long, and he took an active part in the work which raised it to a prominent standing among scientific associations. He was also interested in the American Philosophical Society. In addition to the work connected with these societies and with the university, he was engaged in conducting investigations at his private observatory, where he determined for the first time in this country the periods of the daily variation of the magnetic needle, and by another series of observations the connection of the fitful variations of the direction of the magnetic force with the appearance of the aurora borealis. In 1836 he was elected President of the Board of Trustees of Girard College, and went abroad for the school to investigate European educational methods. This position he resigned six years later, as well as his connection with the free public school system of Philadelphia, and the High School of that city, which he had organized.

Although Prof. Bache's investigations in subjects connected with terrestrial magnetism had been of value to engineers, he was brought into more intimate relations with them in 1843, when he succeeded Mr. F. R. Hassler as Superintendent of the United States Coast Survey. What he accomplished in this office is indicated in a general way by the following extracts from a resolution passed on February 18th, 1867, at a meeting of his former assistants:

"Whatever of excellence there may be in the extended system of operations now carried on by the coast survey on every portion of our

* Memoir prepared from information furnished by A. T. Mosman, M. Am. Soc. C. E., and from papers on file at the House of the Society.

coast is due to Prof. Bache. He came to the charge of the work at a time when its operations were conducted upon a small scale and restricted to a limited portion of the coast. In a wonderfully short space of time he succeeded in winning the confidence of his official superior, and in securing the consent of Congress to a gradual enlargement of the work to its present scale. He called to his assistance men of thought and men of action from civil life, and from the army and navy, and with a rare felicity, discerning and applying the special aptitudes of each individual, he wrought out from discordant material a harmonious whole.

"He combined high administrative ability with vigor and energy in execution. While allowing and inviting free criticism of his plans during their inception, he exacted a rigorous accountability from the officers intrusted with their execution. Discipline under his administration was none the less real that it was not apparent.

"Prof. Bache was eminently just. The Coast Survey reports—those monuments of his fame—are full of evidence of the scrupulous care with which every officer serving under him received proper credit for his labors. His quick and ready appreciation of merit in every department of scientific inquiry and action, whether theoretic or practical, has been felt through the entire country, and has been of lasting benefit. To his fostering care and aid we owe the present perfection of the telegraphic method of obtaining longitude which recently achieved its crowning triumph in the determination by the Coast Survey of the precise difference of longitude between any two points in Europe and America, through the Atlantic cable."

Prof. Joseph Henry said, in his eulogy of him :

"When Prof. Bache took charge of the Survey it was still almost in its incipient stage, subjected to misapprehension, assailed by unjust prejudice, and liable, during any session of Congress, to be suspended or abolished. When he died, it had conquered prejudice, silenced opposition, and become established on a firm foundation as one of the permanent bureaus of the executive government."

His unusual administrative ability has been referred to particularly by most of his biographers. Prof. Fairman Rogers wrote* that he loved to put the machinery of his office together, wind it up, and then dismissing it all from his mind, hear the report at the designated time, when he would take up the thread of the matter just where he had left it last, as if he had thought of nothing else during the interval. "He understood thoroughly the way of doing nothing for himself that could be done for him by others, and thus reserved his time and powers for that work which he alone could do." Nevertheless, his early training in the details of observations was so thorough that interpolated figures are reported to have rarely escaped his notice, and his ability to tell an observer that on such a night he had omitted to examine the level of his instrument was little short of marvelous.

The Coast Survey was only one department of government work with which he was connected, for he was also, at one time or another, Superintendent of Weights and Measures, Lighthouse Commissioner and member of the Lighthouse Board, Regent of the Smithsonian Institute, and a Vice-President of the United States Sanitary Commis-

* *Journal of the Franklin Institute*, May, 1869.

sion. The American Association for the Advancement of Science was founded largely through his influence, as was the National Academy of Science, and he was a president of both these organizations, as well as the American Philosophical Society. Foreign scientists recognized the importance of his work at an early period of his career, and he received many honors from European associations. His published works are many, and a list of them, outside of his official reports, would be too voluminous to print here.

At the request of the Governor of Pennsylvania, although overwhelmed with other public labors, he planned lines of defenses for Philadelphia during the civil war, and, to a certain extent, personally superintended their construction. Unaccustomed for many years to direct exposure to the sun, this work proved too much for his physical strength, and brought on the first indications of that malady which terminated his life.

Prof. Bache died at Newport, R. I., February 17th, 1867, and was buried in the Congressional Cemetery at Washington.

He was elected an Honorary Member of the American Society of Civil Engineers on March 2d, 1853.

ÉMILE MALÉZIEUX, Hon. M. Am. Soc. C. E.*

DIED MAY 20TH, 1885.

Émile Malézieux was born at St. Quentin, France, June 8th, 1822. He entered the École Polytechnique in 1841, and afterward the École des Ponts et Chaussées, from which he graduated in 1846, with next to the highest honors in the class.

After a short tour in England, he was placed in charge of a division, first of construction and later of maintenance, of the canal from the Marne to the Rhône, in the Departments of the Marne, the Meuse and the Meurthe. He held this post for twelve years, serving also during a part of this time on the construction of a portion of the railway from Paris to Strasburg, within the Department of the Meuse.

In 1859 he was assigned to duty in Paris in connection with the construction of the Belt Line Railway, a position he held for ten years. Toward the end of the next year he was also in charge of the canalization of the Marne, in the Department of the Seine, including the construction of the St. Maurice Canal and the Joinville Dam. At the Paris Exposition of 1867 he received a gold medal for the type of metal lock gates introduced by him on the St. Maurice Canal.

In 1868 Mr. Malézieux was appointed to a professorship at the École des Ponts et Chaussées, and was given the course in interior navigation,

* Memoir prepared from papers on file at the House of the Society.

which he retained until 1877. His knowledge of public works led to his being sent in 1870 to this country to examine the works of American engineers. Here he collected a large amount of data, which was subsequently employed in the preparation of his two-volume report, entitled "*Travaux publics en Amérique, en 1870.*" This was so satisfactory that the author was sent three years later on a similar mission to England, which resulted in the publication of another valuable report. These labors were not allowed to interfere with his regular work as a teacher, and, indeed, his original course was supplemented in 1871 by another on general methods of construction.

Early in 1877, his connection with the school was closed, and he was unanimously elected Secretary of the General Council of the Engineering Corps (*Ponts et Chaussées*), where he served with distinction until 1882. Then his health, feeble for several years, broke down, and he was given an indefinite furlough in which to recover. This enforced rest, although fully earned by continuous service since 1846, proved irksome to such an active man, and he applied for reinstatement. This was granted him, and his subsequent work showed no diminution in excellence. His death occurred suddenly on May 20th, 1885, his rank in his corps at the time being that of Inspector-General of the Second Grade.

Mr. Malézieux was elected an Honorary Member of the American Society of Civil Engineers on November 3d, 1880. He was made a chevalier of the Legion of Honor in 1856, and an officer in 1874. He was also a member of the American Philosophical Society of Philadelphia and the Academic Society of St. Quentin.

GENERAL JOSEPH G. TOTTEN, Hon. M. Am. Soc. C. E.*

DIED APRIL 22D, 1864.

General Totten was born in New Haven, Conn., on August 23d, 1788, and graduated at West Point as 2d Lieutenant of Engineers on July 1st, 1805. Resigning in 1806, he served as Secretary to Captain Jared Mansfield, then Surveyor-General of Ohio and of the Northwest Territory. He re-entered the Corps of Engineers as 2d Lieutenant, February 23d, 1808, and then served in that corps until the end of his life.

The war of 1812 furnished full opportunity for the display of his ability. He was assigned as Chief Engineer to the army under General Van Rensselaer, and was engaged in the battle of Queenstown in 1812. He was then transferred to the Army of the North as Chief Engineer under General Dearborn, and was engaged in the capture of Fort George. In 1814 he became Chief Engineer of the army on Lake Champlain under Generals Izard and Macomb, and was engaged at the

* Memoir prepared by Gen. C. B. Comstock, M. Am. Soc. C. E.

battle of Plattsburg, a place which he had fortified. Previously brevetted Major, he was brevetted Lieutenant-Colonel for gallant conduct at Plattsburg.

From 1817 to 1819 he was the Superintending Engineer of fortifications at Rouse's Point, N. Y., and then became a member of the Board of Engineers charged to prepare plans for defensive works for the sea coast of the United States. Its members were then General Bernard and Lieutenant-Colonel Totten. General Bernard was an able officer of the French Corps du Génie, who was Assistant Engineer in our service from 1816 until 1831, when he returned to France, and subsequently became Minister of War. Although naval officers were sometimes associated with the Board of Engineers, as also the resident engineers of local defences, it was on those two, mainly, that the planning of the defensive works on our seaboard devolved, and a large part of the work was done by General Totten.

The system was prepared and was largely executed in a period when a 42-pounder was one of the heaviest guns on shipboard, and when all naval guns were behind wooden walls. It consisted in defending our harbors by a number of guns which should be more than a match for any probable naval attack, these guns being of power equal to those in the English and other foreign navies, and placed behind masonry walls which were impenetrable to the naval fire of the day, or behind other effective cover. In similar foreign defences and in the earlier ones of this period built by us, the embrasures were large, and the gunners were seriously exposed to small projectiles. General Totten devised in the latter part of the period a shutter embrasure lined with masses of wrought iron which largely reduced the embrasure opening, and correspondingly diminished the exposure of the gunners. It was an improvement of the highest value, and in 1855-60, when the plans of defence had been carried far toward completion, our system had no superior in the world, and the credit therefor was largely due to General Totten. But at that time, with the gradual introduction of rifled guns of large caliber, and with the possible use of armor on shipboard, the naval vessels of the world, with their wooden walls, became things of the past, and sea-coast defences had to change to meet the new navy.

From 1838 until his death General Totten worked unremittingly at the duty laid upon him of adequately defending the coast of the United States. No question was too large to be considered, no detail too small to be examined by him. His letters were filled with drawings from his own hand, and, in their terseness, clearness and precision, were models for others.

From 1825 to 1838 he was Superintending Engineer of the construction of one of the largest defences in the United States, namely, Fort Adams, R. I. In 1838 he became Colonel and Chief Engineer, U. S.

Army, and thereafter his station was in Washington. With this change his duties changed so as to embrace the whole United States. They were so performed as to gain the admiration of all save unscrupulous superiors who could not bend him to their schemes.

In the war with Mexico, General Scott, who had the highest opinion of his ability, made him his Chief Engineer during the siege of Vera Cruz, and he was brevetted Brigadier-General for gallant and meritorious conduct at the siege.

In 1862 he was member of a commission to report on the defensive works at Washington and Alexandria.

In 1863 he was made Brigadier-General; on April 21st, 1864, was brevetted Major-General, and on April 22d, 1864, his useful and noble life ended.

From 1846 until his death he was a Regent of the Smithsonian Institution; a corporator and member of the National Academy of Sciences from March 3d, 1863; and a Member of the Light-House Board from its organization in 1852.

He devoted to his country's service great ability, unswerving honesty and unremitting labor. Gifted by nature with an even, well-balanced mind, he was a courteous gentleman, and, what is deeper, he was a good, kind-hearted man.

General Totten was elected an Honorary Member of the American Society of Civil Engineers March 2d, 1853.

SQUIRE WHIPPLE, Hon. M. Am. Soc. C. E.*

DIED MARCH 15TH, 1888.

Squire Whipple, the son of James and Electa Johnson Whipple, was born in Hardwick, Mass., on September 16th, 1804. His father was a farmer and later the owner of a small cotton mill, and the son spent the earlier period of his life in work connected with the farm and the mill. For about six months in each year he attended the district schools of Hardwick until he was thirteen years of age, at which period, or in 1817, his father removed to Otsego County, N. Y., and the son again assisted him in farming. After teaching school for a time Squire Whipple attended the academical schools of his neighborhood, and in 1829 he entered the senior class of Union College, at Schenectady, N. Y., and was graduated one year later, with the degree of A. B., from that institution.

His early connection with the machine shops of his father's mill at Hardwick had assisted in developing a natural inclination towards mechanical pursuits and had to a certain extent guided him in his

* Memoir prepared by D. McN. Stauffer, M. Am. Soc. C. E.

studies. The construction of the Erie Canal and other public works nearby induced him later to enter the new and then very vaguely defined field of civil engineering, and, upon leaving Union College in 1830, he sought occupation of this character. He first found work as a rodman, and later as leveler, upon the Baltimore and Ohio Railroad; but his service with that company seems to have been short, and he was chiefly occupied for some years under Holmes Hutchinson, late of Utica, N. Y., in fixing the boundaries of land necessary for the construction and maintenance of parts of the Erie Canal, and in surveys and estimates for the enlargement of this waterway. In 1836-37, he was for a short time resident engineer on the Eastern Division of the New York and Erie Railway, under the late Edwin F. Johnston, as chief engineer; but work was soon suspended upon this enterprise and he was out of employment. With the exception of five or six surveys and reports upon projected railways and canals, submitted between 1837 and 1850, the list here mentioned constitutes about all of the experience of Mr. Whipple in general field practice.

In the intervals of enforced leisure Mr. Whipple turned his attention to the manufacture of engineering field instruments; and about 25 leveling instruments and several fully equipped transits were made by him at this time. In 1840 he brought out his first invention of any note in the form of a scale for weighing canal boats of from 200 to 300 tons. He made a model and later built the first enlarged weighing lock scale ever constructed upon the Erie Canal. This scale worked satisfactorily and served as a model for others built by Mr. Whipple and those following his designs.

Mr. Whipple's first patent for an iron truss bridge was taken out on April 24th, 1841, and, while this was not for a pin-connected truss, it possessed some of the features of the present practice in bridge design. As well as can be learned from the meager drawings and specifications then submitted for United States patents, this bridge may be described as follows: The top chord was a cast-iron arch, of channel section, widening in plan from the center towards the ends, built in sections "from 10 to 20 ft. long," and with the several parts united at the panel points by a kind of socket joint with a pin passing through both parts of the arch. The bottom chord was made of round rods, apparently connected at the foot of each vertical to a channel-shaped casting, which served as a transverse floor-beam, and secured by nuts inside this channel. The verticals were round iron rods, somewhat vaguely described as acting "as both ties and posts," and the diagonal system in each panel was made of rods, or "braces of cast iron," placed in pairs. According to the drawing, these diagonal rods were secured by nuts to the top chord and to the transverse floor-beam before described. Mr. Whipple built a number of these bridges, with spans ranging from 70 to 100 ft., over the Erie Canal, and of the fifty

iron bridges erected in the United States prior to 1850 these structures constituted the large majority.

About 1852, Mr. Whipple designed and built several short and unimportant iron railway bridges upon the New York and Erie Railway; but though they successfully withstood severe tests and were in use for some months, they were removed owing to a panic caused by the failure of another iron bridge on the same line, of different design and proportions. But in 1852-53 he constructed a Whipple trapezoidal iron railway bridge, of 146-ft. clear span, upon the Rensselaer and Saratoga Railroad, near West Troy, N. Y. This is claimed to be the first iron bridge built with inclined end-posts, and the type was afterwards well known as the Whipple truss. It successfully withstood the gradual increase in the weight of rolling stock until 1882, when it was taken down and replaced by a double-track structure of modern design.

From an illustrated description of this bridge, written by Squire Whipple himself and published in *Engineering News* of April 7th, 1883, the following brief abstract is made: This bridge had parallel top and bottom chords, inclined end posts and a double intersection diagonal system, with the compression members made of cast-iron. The bottom chord was constructed of iron links of various diameters connecting over cast-iron trunnions forming a part of the cast post-shoe. The top chord was constructed of hollow cast-iron cylinders abutting on a round pin above the post; and this pin rested upon a semicircular groove in an extension of the post and also secured the tops of the diagonal members, which were provided with an eye for this purpose. The lower ends of the diagonals passed through the cast post-shoe and were secured there and adjusted by nuts. The posts were tapering hollow castings, in four sections, bolted together by flanged joints and trussed at the center to guard against buckling and to compensate for an opening left in the center of the post for the passage of the diagonals. While this bridge might be said to be pin-connected above, the bottom connection was made by the cast-iron trunnions before mentioned, which were from 7 to 9 ins. long and 3 ins. in vertical thickness, and rounded off at both ends to fit the links. This bridge was built upon a skew, with an angle of 44° , and it was originally submitted to a test of 150 tons of railway iron, distributed, and the passage of a 40-ton locomotive drawing a train of loaded freight cars covering the bridge. It was proportioned for a rolling load of 1 ton per foot only, and was probably the lightest iron railway bridge of like span ever constructed, for the metal in it is said to have weighed only 75 000 lbs., 43 000 lbs. of this being cast iron.

Early in 1847 Mr. Whipple published a brief but practical treatise upon bridge designing; and in 1869 he issued a continuation of this work, for which he set the type, made the woodcuts and printed off the sheets on a small hand-press at his own home. This original treatise is noticeable for the general soundness of his reasoning, and

as being one of the very earliest attempts to handle the problems of bridge design and proportions upon well-digested scientific principles.

The full title of the book, as printed by H. H. Curtiss, of Utica, N. Y., was: "A Work upon Bridge Building, Consisting of Two Essays, the One Elementary and General, the Other giving Original Plans and Practical Details for Iron and Wooden Bridges." In this treatise Mr. Whipple pointed out and illustrated the fundamental law of framed structures and gave rules and formulas for determining the exact amount of stress brought upon the several members of a truss or bridge. He also discussed the relative economy of various arrangements of members, and, in fact, forecast much that is now actual practice. Mr. Whipple claimed no originality for the use of diagonal members between parallel chords; but he appears to have been the first to use pins in a truss of this character and to adopt the inclined end post, now in such common use.

In 1872 he published an enlarged edition of his book on bridge building, and a fourth edition was put out in 1883, including in this list of editions that of 1869, printed by himself. In 1866 he also published, at Albany, N. Y., a pamphlet entitled "The Doctrine of Central Forces, Illustrated Without the Use of the Calculus."

Among his other inventions was a lifting draw-bridge, designed by him in 1873 to meet various difficult conditions found in carrying streets across the Erie Canal. The chief feature of this bridge was a counter-balanced floor suspended to an elevated trussed structure spanning the canal. When space was required for the passage of boats this floor was lifted by gears and shafting, sufficiently to allow the boats to pass beneath. He built one of these lift bridges in Utica, over the Erie Canal, and it is believed to be still in use.

Personally, Mr. Whipple was of a retiring disposition, preferring the quiet of his study and mechanical experiments to the society of any except his few most intimate friends. To the latter he was always genial and entertaining. From his youth upward he had an inveterate aversion to violence of any kind, and especially as this violence was exhibited towards the dumb creation. For this reason he had always abstained from animal food, except such as is produced in the dairy, and he published, in 1847, a small pamphlet called the "Way to Happiness," in which he ably defended his position and his peculiar diet. He claimed that his practice was in the interest of good health, rational economy and sound morality, and the fact that he was the last of a family of ten children and lived to a sturdy old age himself would seem to indicate that he found some virtue in his peculiar methods and views.

Squire Whipple was elected an Honorary Member of the American Society of Civil Engineers, on May 6th, 1868. He died at his home in Albany, N. Y., on March 15th, 1888, in his eighty-fourth year, leaving a widow but no children.

WILLIAM MILNOR ROBERTS, Past-President Am. Soc. C. E.*

DIED JULY 14TH, 1881.

William Milnor Roberts was of Welsh descent. His family were members of the Society of Friends, who came to America with William Penn. They resided in Philadelphia, and a grandfather and an uncle served as mayors of that city. His father's name was Thomas Pascal Roberts. His mother was Mary Louise Baker, and he, their eldest son, was born February 12th, 1810. He was educated at one of the schools of the Society of Friends, taking also two terms of a special course in mathematics under Professor Joseph Roberts. He then became a pupil of the first school established by the Franklin Institute, and there was taught architectural drawing by John Haviland, a well-known architect of that period.

In the spring of 1825, when hardly past his fifteenth birthday, he was made a member of the engineering corps engaged in the construction of the Union Canal of Pennsylvania. From that moment up to the day of his death, in July, 1881, his life was one of continued activity and of devotion to his profession. During those sixty-six years he saw, and in fact was a very important factor in, the wonderful development of public works, which was guided and directed by the civil engineers of America. When he began his engineering service in 1825, there was no railroad in operation in that country. The improvement of means of transportation by water was in active progress. The Erie Canal in New York, begun in 1817, was completed from Buffalo to the Hudson in October, 1825. The State of Pennsylvania had determined by legislative act to adopt and prosecute a canal system. The Chief Engineer who gave a position to William Milnor Roberts was Mr. Canvass White, who had been one of the engineers of the State of New York in the location and construction of the Erie Canal, and who first introduced the use of hydraulic cement in the construction of its masonry, having discovered in 1818 a stone in central New York from which it was made. The chief of the party in which the young man served was Mr. Sylvester Welch, a severe disciplinarian and accomplished engineer. The devotion and energy of the young assistant commended him both to Mr. White and Mr. Welch, and their opinion of him was shown by his rapid promotion to positions of responsibility. Mr. Roberts was really for a number of years both pupil of and assistant to Mr. Welch. In 1826 he was rodman with Mr. White in a survey made across the Allegheny Mountains with special reference to the construction of a macadamized road to connect the water transportation on the eastern and western slopes. In 1827 he was sent by Mr.

* Memoir prepared by John Bogart, M. Am. Soc. C. E.

White as a young assistant upon the survey and construction of the Lehigh Canal, and here he made his first acquaintance with a railroad at the inclined planes at Manch Chunk. He aided Mr. White in making improvements at those planes, and thus took part in the construction and operation of one of the earliest railroads in the United States. He was one of the passengers on the first trip of the first passenger car actually run on rails in this country.

He continued his service on the Lehigh River and Canal improvement until 1831, when he was appointed Senior Assistant Engineer under Mr. Sylvester Welch, Chief Engineer of the proposed Allegheny Portage Railroad. Surveys and plans for this road had been made in 1829 and 1830 by Mr. Moncure Robinson and by Col. Long, both including eleven planes, although not on the same location. Mr. Roberts suggested to Mr. Welch ten planes, all straight and with inclinations of from $7\frac{1}{2}$ to $10\frac{1}{2}$ per cent. He superintended the construction of the five on the eastern slope, and of three on the western slope. In 1832 he rode with Chief Engineer Welch across the country on horseback, and visited the inclined planes on the Morris Canal, and those on the Carbondale and Honesdale Railroad. He spent much time during that year also upon the Western Division of the Pennsylvania Canal, directing repairs made necessary by the great flood of February, 1832. On November 21st, 1833, the Allegheny Portage Railroad was finished, and a train of cars, drawn by horses on the levels, was passed over all the planes. It was opened to the public in 1834. Any persons who chose could put cars upon it, and haul them on the levels with their own horses. Mr. Roberts was given the general charge and management of the running of the road, and continued in this position until January, 1835, when he resigned and was appointed Chief Engineer of the Lancaster and Harrisburg Railroad.

This closed the first ten years of the engineering life of Mr. Roberts. At the age of twenty-five he had become the chief engineer of an important railroad enterprise presenting novel problems of location and construction, and with very little in the whole country to serve as model or guide. There must have been great promise in the young man to lead to his selection for such responsibilities. In fact, he had already developed the characteristics and qualifications which showed so clearly in his subsequent career. The history of that career will be concisely sketched directly.

Mr. Roberts did not have the education of the technical school; in fact, technical schools did not then exist. When he was young, there were no libraries of engineering information. The records of experience and the deductions from such records were in private notebooks, and in correspondence with the very limited number of active engineers. Specialism was not thought of. The varied questions which arose could not be referred—they must be answered at once.

No men could succeed under such circumstances except those specially fitted for the task. Mr. Roberts was a very close and minute observer of physical facts related to engineering problems. He kept voluminous notes, and he had a very retentive memory. He had a special aptitude for design, and an appreciation of what was essential and non-essential in each particular case. He had much mechanical ability, and could draw without instruments a plan which would be surprisingly close to scale. He had in addition untiring energy and extreme devotion to the work of the moment. His diaries and letters and the statements of friends who were associated with him are full of the stories of his remarkable capacity for work. His frequent trips on horseback were for long distances and at great speed, and these never seemed to interfere with his ability for the immediate direction of affairs. In fact his life was of unceasing activity, not only in his younger days, but up to the very last. His physique enabled him to endure great fatigue. He was of moderate height, never corpulent, but of a wiry and muscular frame. In his younger days he was very fond of athletic sports, particularly of skating, in which he was very skillful. He was physically strong and personally brave. On one occasion, at the risk of his own life, he rescued an Indian mother and child who had fallen into Lake Erie from the deck of a steamer on which he was a passenger. In making a reconnaissance of a new region, riding with farmers or guides familiar with the trails, he would astonish them by the accuracy of his estimates of the distances traveled.

He permitted nothing to interfere with professional honesty to his duties. In two particular instances, one quite early in his charge of important work, the other after the war, he tendered his resignation of his position, when an attempt was made to influence politically his engineering appointments.

He was not a student in that sense of the word which is defined as one given to the study of books, but he was a student in the other sense, as one given to the acquisition of knowledge. His writings therefore were generally descriptions of actual observations and expressions of opinion as to the application of experience to new problems. He seldom developed mathematical theories, and he expressed at times doubts as to the reliance to be placed upon a too free use of theoretical formulas, particularly in cases where it could not be certainly known that the existing conditions were the same as those from which the formulas were deduced. The story of his professional life shows that he had a very large opportunity to study the problems of the movement and action of water. He was engaged in the improvement of many important rivers, among them the Monongahela, Ohio, Lehigh, Juniata, Kiskiminetas, Allegheny, Big Beaver, Little Beaver, Des Moines and Mississippi, and he had been during early life in the engineering corps in charge of the

extensive canal works of Pennsylvania. In a letter referring to the discussions upon the vexed questions connected with the improvement of the outlet of the Mississippi he wrote:

"The nice mathematical theories of 'threads of water,' 'waves of translation,' 'radius vector,' etc., are well enough in their proper places. I do not object to them; but if a man has all of these and analogous things at his finger end, and has not practical experience in the actual operation on a large scale of water in rivers and canals, his judgment might easily be at fault when undertaking to plan river works or to criticise river plans. Gravity being the father of the whole thing, of course, he looks carefully after all his children. It is curious how simple things may be made mysterious."

This distrust of too free use of theory did not prevent him from being a welcome associate with many of the most distinguished theoreticians in the practice of engineering science. His wonderful fund of information, his knowledge of engineering facts, his lucid discussions, his unfailing good nature, and his excellently educated common sense, made him always a reliable and successful consulting or chief engineer, and a valuable member of many important commissions.

Mr. Roberts was Chief Engineer of the Lancaster and Harrisburg Railroad during 1835, 1836 and 1837. He located it with a maximum grade of 39.6 ft. per mile, grave doubts existing as to the capacity of a locomotive to haul loads on a steeper grade. At that time grades of 50 ft. per mile were operated in England, as inclines with rope traction. In 1836 he was made Chief Engineer of the Cumberland Valley Railroad, and finished the construction of both lines. During this year he visited Alexandria, Va., where he made a contract for two locomotives; New Castle, Del., one locomotive; Norris Works, Philadelphia, four locomotives; and Lowell, where, however, he could not secure any locomotives because of the extent of previous orders for other roads. In 1837 he built the combination lattice-truss bridge crossing the Susquehanna at Harrisburg, with a double-track railroad on top, and a double carriage-way and footpaths below. In 1838, 1839 and 1840, while still Consulting Engineer for the above-mentioned railroads, he took charge as Chief Engineer in the State service, of the extensions of the State canals of Pennsylvania, the work in progress extending from Erie, southerly, to Pittsburg, and thence still southerly on the Monongahela to the Virginia line, the latter being for the Monongahela Navigation Company. His duties carried him over wide tracts of country which he generally traversed on horseback, keeping three horses in service, and he generally rode from 30 to 40 miles a day, sometimes 50, and once 68 miles. During 1841 and 1842 he was engaged on the enlargement of the Welland Canal in Canada; 1843 and 1844, the Erie Canal of Pennsylvania; 1845 to 1848, Chief Engineer and Trustees' Agent for the Sandy and Beaver Canal in Ohio. During the latter year at the request of the Legislature of Pennsylvania he recommended a line for avoiding the Schuylkill inclined plane near Philadelphia,

which was adopted and built substantially upon the route now used by the Pennsylvania Railroad. In 1849 Mr. Roberts declined the Chief Engineership of the first projected railroad in South America, to accept that of the Bellefontaine and Indiana Railroad where he remained until 1851. From 1852 to 1854 he was Chief Engineer of the Allegheny Valley Railroad, Consulting Engineer for the Atlantic and Mississippi Railroad, contractor for the construction of the Iron Mountain Railroad, and Chairman of a commission of three appointed by the Pennsylvania Legislature upon the reconstruction of the Allegheny Portage Railroad. This commission recommended the abandonment of the inclined planes and the construction of a railroad with maximum grades of 75 ft. per mile, which plan was adopted and the road built by the State. The Pennsylvania Railroad had previously built its line with grades of 95 ft. per mile. The two lines were within sight of each other, and the State railroad was soon after bought by the Pennsylvania.

This was the period of the battle of the railway gauges, and for awhile it seemed that the decision would be in favor of the wider, 6 ft. or more, as against the gauge of 4 ft. 8½ ins. While Chief Engineer of the Allegheny Railroad, which was to connect the Pennsylvania and New York systems, Mr. Roberts strongly advocated the narrow width. The officials of the company at first disagreed with him, and the ties were laid for the wide gauge, but when the rails were placed he succeeded in securing the adoption of what is now the standard gauge.

During 1855, 1856 and 1857 Mr. Roberts was engaged in the construction of the Keokuk, Des Moines and Minnesota Railroad and the Keokuk, Mt. Pleasant and Muscatine Railroad. He was also Consulting Engineer for the Pittsburg and Erie and for the Terre Haute, Vandalia and St. Louis roads. In December, 1857, he went to Brazil; in May, 1858, closed the contract for the construction of the Dom Pedro Segunda Railroad, and as a senior member of a firm built that road. It had thirteen tunnels in 9 miles, one, 7 200 ft. long; there were 3½ miles of tunnel in 9 miles of line. Mr. Roberts was in Brazil until the latter part of 1865, when he took charge of the surveys for the Atlantic and Great Western road, completing them in 1866. He was then appointed on the Commission which recommended the plans for the improvement of the Mississippi River at Keokuk, and in 1866 was appointed United States Civil Engineer in charge of the improvement of navigation of the Ohio River, continuing in this position till 1870. During this time, while on leave, he was in 1868 appointed, at the suggestion of Mr. Eads, Associate Chief Engineer to the St. Louis and Illinois Bridge Company, on the occasion of the visit of Mr. Eads to Europe on account of the serious condition of his health. Mr. Roberts continued in the service of the bridge company two years. He was constantly engaged in conjunction with the other engineers, Messrs.

Flad and Pfeifer and Mr. McComas, the General Superintendent, in the personal direction of the sinking of the caissons of both the east and west piers, a work of novelty, delicacy and danger.

In the fall of 1869 Mr. Roberts became Chief Engineer of the Northern Pacific Railroad and continued in that position until his departure for Brazil in 1879. During this period he made extended surveys and examinations along the various parts of this transcontinental route, including trips over the western mountain passes. In addition to this service he made, in 1873, examinations and a report upon the Marquette and Mackinaw, and upon the Minneapolis and St. Louis Railroads. In 1874 he was made a member of the commission appointed by the President of the United States to examine and report upon the proper method of improving the mouth of the Mississippi. The other members were Gen. H. G. Wright, U. S. A.; Gen. B. S. Alexander, U. S. A.; Gen. C. B. Comstock, U. S. A.; Prof. Henry Mitchell, U. S. Coast Survey; T. E. Sickles, M. Am. Soc. C. E., and H. D. Whitcomb, M. Am. Soc. C. E. This commission visited the mouths of various European rivers. Their report was made January 14th, 1875. In 1874 he also reported upon the water-works of Pittsburgh. In 1875 he was a member of a commission to examine and report upon the Water Supply of Philadelphia. He was also a member of the Advisory Commission of Engineers upon the construction of the South Pass jetties at the mouth of the Mississippi River. This board met first on September 2d, 1875. Its members were Gen. J. G. Barnard, U. S. A.; Gen. B. S. Alexander, U. S. A.; Sir Charles A. Hartley, W. Milnor Roberts, T. E. Sickles, M. Am. Soc. C. E.; Prof. Henry Mitchell, U. S. Coast Survey, and H. D. Whitcomb, M. Am. Soc. C. E. This board made its report November 20th, 1875, approving the works in progress.

In 1878 he was in Nova Scotia in connection with the location of the Nova Scotia, Nictaux and Atlantic Railway. In September of that year he was in Washington Territory, and crossed the Cascade Mountains on muleback. In December he concluded a contract for three years with the government of Brazil to act as engineer for that government on any public works, and on January 4th, 1879, left New York for Rio de Janeiro. After his arrival he made examinations of the port of Santos, of the Sao Francisco River, and of the ports of Pernambuco, Fortaleza, Maranhao, Vitoria and Caravellas. He also made a report on the water-works of Rio de Janeiro. On July 2d, 1881, he started to make an examination of the Rio das Velhas. He was compelled to suspend his journey on the 7th at a small settlement called Soledade in the province of Minas Geraes. His indisposition developed into typhoid fever, and he died at that place July 14th. He was buried in a neighboring cemetery, but was afterwards removed and buried in Woodlands Cemetery in Philadelphia, Pa.

Mr. Roberts was highly esteemed in Brazil, and especially by the engineers of that country. After his death the Engineers' Club of

Rio de Janeiro sent to the American Society of Civil Engineers a communication expressing its personal and professional regard and appreciation of the services of Mr. Roberts, and its regret for his sudden death. This communication was accompanied by a bound volume of illustrations of the Dom Pedro Segunda Railroad, which Mr. Roberts began building in 1858, and which was the last railroad over which he traveled.

Mr. Roberts became a member of the American Society of Civil Engineers September 21st, 1870. He was elected Director in November, 1876; was Vice-President November, 1873, to 1876, and November, 1877, to 1878, and was made President of the Society November 6th, 1878. During the Exposition at Philadelphia in 1876 he was Chairman of the Finance Committee of the Centennial Commission of the Society, and devoted much time to the work of that commission. A number of papers and discussions by him have been published in the *Transactions*.

Mr. Roberts married June, 1837, Annie, daughter of Chief Justice John B. Gibson of Pennsylvania. She died in 1857. He married again in November, 1868, Adeline, daughter of Mr. Anthony Beelen, of Pittsburg, who survives him. He had six children by his first wife, and three by the second.

This memoir would be incomplete without a reference to the peculiar charm of the personality of Mr. Roberts. He was eminently social. He was always bright, hopeful, full of anticipation of good results from his earnest work. His character showed clear, straightforward, charming. In troubled seasons, and he had experiences of them, he was ever looking for the sunshine soon to come.

He was a remarkably rapid and voluminous writer, particularly enjoying correspondence with friends. Many of his letters, pages in extent, were written on railway trains, or in the evenings of days which had been so full of work as to tire out all his companions. These letters were witty, cheerful, full of kindly thoughts, and also full of most interesting details of the journey or the professional works which had been seen during the previous days.

He was a most genial companion, in fact he was the cheery life of the assemblages of which he was a part. He had a bright sense of humor, and a constant fund of stories of his varied experiences. He was always very dear to his friends.

His professional life began with the beginnings of American engineering. He took part in the earliest canal constructions, and in those improvements of river navigation which preceded the railway. In the fullness of his experience he aided in the most important development of the treatment of great rivers the world has ever known. He was one of those brave pioneers who built the first railroads of our country; and before the end of his life, he was the chief engineer of a great transcontinental line. With all his achievements and experiences, he was always unassuming, genial, courteous, "a true and kindly gentleman, pure and modest."

JOB ABBOTT, M. Am. Soc. C. E.*

DIED AUGUST 18TH, 1896.

Job Abbott was born at Andover, Mass., August 23d, 1845. He attended the district schools and Phillips Academy before going to Harvard, where he studied engineering in the Lawrence Scientific School. After graduating in 1864, he was connected for a time with the Manchester Locomotive Works, but his active engineering work began when he was appointed Assistant Engineer on the Glen Cove branch of the Long Island Railroad. This engagement was a short one, and on its termination he went to the Pittsburg, Ft. Wayne and Chicago Railway in a similar capacity. While on this line he became interested in the city of Canton, O., a large part of which he laid out, and there he had an office as civil and mining engineer and patent expert from 1866 to 1872. During this time he studied law and was admitted to the Ohio bar.

While practicing patent law in Canton he was retained on certain matters by the Wrought Iron Bridge Company, and became so interested in these affairs that he dropped his legal practice to take up engineering again. He was Vice-President and Chief Engineer of the Wrought Iron Bridge Company from 1872 to 1880, and remained a Director until his death. During this time he built some bridges in Canada, and believing the Canadian business to have a bright future, he helped organize the Toronto Bridge Company, of which he was President and Chief Engineer from 1880 to 1884. The business in Toronto soon outgrew the capacity of the shops there, and Mr. Abbott accordingly helped to organize the Dominion Bridge Company of Montreal, of which he was President and Chief Engineer from 1884 to 1888, and President until 1890. The shops of both these companies were designed, erected and equipped under his direction, and during his connection with them he built some of the largest bridges in Canada. In 1884 and 1885 he designed and had charge of the 477-ft. steel cantilever bridge at St. John, N. B.; in 1887, a steel bridge 2 020 ft. long on the Fredericton Railway; in 1888, the superstructure of the Canadian Pacific bridge, 2 440 ft. long, at Sault Ste. Marie; in 1889, the Grand Narrows steel bridge, 1 715 ft. long, on the Dominion Government Railway in Cape Breton, N. S. In 1886 and 1887 he also had charge of building the superstructure of the Lachine Bridge, 3 660 ft. long, over the St. Lawrence River on the Canadian Pacific line.

In 1889 he found he was working too hard, and gave up his Montreal office in order to remove to New York, where he established an office as consulting engineer, which he maintained until April, 1896.

* Memoir prepared from papers on file in the House of the Society.

In 1889 and 1890 he designed and had charge of the Ohio River Bridge at Wheeling, W. Va., and was appointed Chief Engineer of the Wheeling Bridge and Terminal Railway Company. The work done by this company was very heavy, the bridge alone being a double-track structure 2 097 ft. long with a 525-ft. channel span.

After the completion of the Wheeling works, Mr. Abbott was retained as Consulting Engineer for the Bangor and Aroostook Railroad in Maine, the longest line built in New England since the Central Massachusetts was finished. While engaged in Maine in work for this road, he was taken ill but kept at his labors for about a year, when he went to Andover for health and rest. He was too late, however, and after a trying sickness died August 18th, leaving a widow.

Mr. Abbott was elected a Member of the American Society of Civil Engineers, April 1st, 1891.

WILLIAM ALBERT ALLEN, M. Am. Soc. C. E.*

DIED MARCH 21st, 1896.

William Albert Allen was born at Bath, Me., October 18th, 1852. He graduated in 1874 from the Maine State College, where he studied civil engineering, and a year later entered the service of the Maine Central Railroad Company as assistant engineer. At that time the policy the management of this company was rapidly adopting aimed at the construction of a modern, high-class road-bed with good iron bridges, and Mr. Allen's attainments made him a valuable man for such work. In April, 1877, he was made Civil Engineer of the road, and in January, 1885, was promoted to the position of Chief Engineer, with the control and responsibility that the title implies. In 1887 and 1888 he was also Chief Engineer of the Portland Union Railway Station Company, and held the office from the commencement of the work until the completion of the station, train-shed and approaches.

Mr. Allen lost his life on March 21st, 1896, while inspecting work that was being done on the railway bridge between Auburn and Lewiston. He was leaning out from the steps of a car to observe the progress of the work, when he lost his hold or was struck by a telegraph pole. He fell from the car to the bridge, from which he dropped into the river above the falls at this place. He was carried over the falls and his body was not recovered until some weeks later. He was a widower and left no children.

Mr. Allen was elected a Member of the American Society of Civil Engineers, May 6th, 1891.

* Memoir prepared from information furnished by Mr. H. C. Robinson, Assistant Engineer Maine Central Railroad, and from papers on file at the House of the Society.

JAMES BARNES, M. Am. Soc. C. E.*

DIED FEBRUARY 12TH, 1869.

General James Barnes, a prominent engineer and railroad contractor before the Civil War, and the forty-fourth Member of the American Society of Civil Engineers, was a native of Massachusetts. He was graduated in 1829 from the United States Military Academy at West Point, ranking five in a class that included, among others, Robert E. Lee and Joseph E. Johnston, against whom he was destined to carry out later those principles of warfare which they studied as classmates. After graduation he was appointed to the artillery branch, and served for about a year at the Academy as an Assistant Teacher. From 1830 to 1833 he was on duty at Fort McHenry, Md.; Charleston, S. C., and Fort Monroe, Va. Then he served as an Assistant Instructor of Infantry Tactics at West Point until August, 1836, when he resigned to enter upon a prosperous career as engineer and contractor.

From 1836 to 1842 he was Assistant Engineer of the Western Railroad, extending from Worcester, Mass., to Albany, N. Y., and now a part of the Boston and Albany Railroad, and from 1842 to 1848 he was its Chief Engineer and Superintendent. Then he went south, and from 1842 to 1848 was Chief Engineer and Superintendent of the Seaboard and Roanoke Railroad from Norfolk, Va., to Weldon, N. C. It was during this time that he became interested in contracting as a member of the firm of Phelps, Mattoon and Barnes, of Springfield, Mass., builders of the Watertown and Rome Railroad. This was a very successful contract, and led to his engaging in this business for a number of years, during which he built the Sackett's Harbor and Ellisburg Railroad, part of the Buffalo, Corning and New York Railroad, the Terre Haute, Alton and St. Louis Railroad and the Potsdam and Watertown Railroad. During 1853 and 1854, he resided in Russia, where he was retained by the Russian Government as Consulting Engineer of the railway from St. Petersburg to Moscow.

On the outbreak of the Civil War, General Barnes at once volunteered, and became Colonel of the 18th Massachusetts Infantry in July, 1861. He served with distinction in the operations of the Army of the Potomac, and was in command of a division at the battle of Gettysburg, in which he was wounded. During the latter part of 1863 he was in command of the defences of Norfolk and Portsmouth, Va., and then spent six months on court martial duty. He was in

* Memoir prepared from an article in the "Biographical Register of the Graduates of the U. S. Military Academy," by Gen. G. W. Cullom, and from information furnished by John S. Barnes, Esq.

command of the military prison at Point Lookout, Md., and of the St. Mary's District until the middle of 1865, when he was placed on waiting orders. On March 13th, 1865, he was brevetted Major-General of Volunteers for meritorious services during the Rebellion, and on January 15th, 1866, he was mustered out of service.

In 1868 he was a member of a special United States Commission to examine and report on the road and telegraph line of the Union Pacific Railroad Company.

He was a hard student all his life, a good Greek and Latin scholar, and able to speak and write German, French, Spanish and Russian fluently. His business methods were careful and exact, and his personal attributes endeared him to all who knew him intimately.

General Barnes died at Springfield, Mass., February 12th, 1869, at the age of sixty-three years. He was elected a Member of the American Society of Civil Engineers March 13th, 1853.

HENRY ISAAC BLISS, M. Am. Soc. C. E.*

DIED JULY 10TH, 1896.

Henry Isaac Bliss was born at Hartford, Conn., January 8th, 1830. He entered Yale College in 1848, but previous to that time had studied engineering, and had some practical experience. After graduating from the college in 1853, he went at once to Wisconsin and became connected with the construction of the Milwaukee and Fond du Lac Railroad, afterward the La Crosse and Milwaukee Railroad, and now part of the Chicago, Milwaukee and St. Paul system. In the fall of 1854 he returned to Connecticut, and was engaged near Middletown on the construction of the Boston and New York Air Line Railroad until work was suspended in 1855. Then he returned to Wisconsin and made a survey of the La Crosse and Milwaukee Railroad from La Crosse to the Wisconsin River.

In the spring of 1856 he settled in La Crosse, which remained his home up to the time of his death. He at once became engaged in engineering and the real estate business, and made a number of railway surveys. From 1860 to 1884 he was City Engineer of La Crosse, and during this time laid out much of the city as it now stands, and built the municipal water-works plant. He was elected a Member of the American Society of Civil Engineers on September 5th, 1883. Mr. Bliss was in feeble health for some time previous to his death on July 10th, 1896. He leaves a widow and married daughter.

* Memoir prepared from papers on file at the House of the Society.

HENRY D. BLUNDEN, M. Am. Soc. C. E.*

DIED JANUARY 7TH, 1889.

Henry D. Blunden was born at Poling, England, April 8th, 1849. He was educated at Brighton and London, England, and at the age of 16 years was articled to John Lawson, C. E., for a term of four years. During 1869 and 1870 he was employed as Contractor's Engineer on the construction of the Mansfield and Southwell Branch of the Midland Railway, England. From August, 1870, to July, 1872, he was Assistant Engineer on the Kansas Pacific Railway, making preliminary surveys and locating new towns; from July, 1872, to July, 1873, Assistant Engineer on the Leavenworth, Lawrence and Galveston Railway, making preliminary surveys and building machine shops; from July, 1873, to 1882, Assistant Engineer on the New York, Lake Erie and Western Road. During 1882 and 1883 he was Road Master on the Eastern Division of the Erie Road, and on September 13th, 1883, he was appointed Engineer of Maintenance of Way of the same road, holding this position until 1886. During 1887 and 1888 he was Assistant Engineer at the Union Bridge Company's shops at Athens, Pa., and was also during this time Superintendent of Bridges on the Pennsylvania and New York Railway, and the Geneva, Ithaca and Sayre Railway. His death occurred January 7th, 1889.

Mr. Blunden was elected a Junior of the American Society of Civil Engineers on January 5th, 1876, and a Member on February 4th, 1880.

ROBERT BRIGGS, M. Am. Soc. C. E.†

DIED JULY 24TH, 1882.

Robert Briggs was a native of Boston, Mass., being born in that city on June 18th, 1822. His early education was obtained in the Boston public schools, and, while there, his aptitude for mathematics, which was afterwards one of his marked characteristics, was noticeable. His engineering training began at the age of seventeen, in the office of Alexander Parris, a local engineer and architect, where he remained for several years. His subsequent career was remarkable for the wide range of engagements it embraced. He designed and erected industrial plants of great size, and afterwards operated them, turning out a

* Memoir prepared by W. B. Coffin, M. Am. Soc. C. E.

† Memoir prepared from information furnished by Henry G. Morris, M. Am. Soc. C. E., and papers on file at the House of the Society.

great variety of products, ranging from tubes to pumping engines. His practice as civil engineer was equally broad. In addition to the professional attainments which enabled him to carry on these works with marked success, he was a clear and ready writer on technical and scientific subjects, the author of several papers before engineering societies, and the editor, for a time, of a well-known scientific journal. The surprising thing is, that, with such versatility and such success in practical charge of important work, he was never a strong man, and was frequently invalidated and prevented from putting into full play the unusual gifts he possessed.

From 1844 to 1847 Mr. Briggs was not engaged in engineering work, but in the latter year he worked for a few months on a railway line in Massachusetts. Then he became Constructing Engineer of the Glendon Rolling Mill, an important establishment then in course of construction at East Boston, and thus acquired his first taste of a branch of work in which he was destined to achieve a marked success in later years. When the mill was finished, he opened an office in Boston as a Consulting Engineer. This proved unprofitable, and he soon entered the service of Walworth & Nason, of Boston, with whom the application of steam to the warming of buildings in this country may be said to have originated. Mr. Briggs took a deep interest in this subject and in ventilation, and wrote several valuable papers on the subject, one of which was published in Volume X of *Transactions* of this Society. He took charge of the construction of the tube works of Walworth & Nason, and, when it was finished, served as its Superintendent for some time.

His restless nature compelled him to seek another field of work before long, and in 1852 he became Superintending Engineer of the firm of Bird & Weld, later the Phoenix Iron Works, at Trenton, N. J. After a year in this place he moved to Mount Savage, Md., to become Superintendent of a rolling mill there, for a period of six months. Then he went to Troy, N. Y., as Superintendent of the Rensselaer Rolling Mill, a position he held for a year. After this experience in mechanical engineering, he turned his attention to civil engineering and architecture again, as Assistant Engineer under General M. C. Meigs. He was engaged on the construction of the Washington aqueduct, the dome of the Capitol at Washington, and the heating and ventilating systems of the halls of Congress. In connection with the last work he made an investigation into the proportions of rotary fans, the results of which were subsequently embodied in a paper presented to the Institution of Civil Engineers, and given the Watt medal and Telford premium of that society.

In 1857 he became a member of the firm of Nason, Dodge & Briggs, of New York, but this connection was brief, for in 1860 he went to Philadelphia as Superintendent and Engineer of the Pascal Iron Works

of Morris, Tasker & Company. This position was the longest he ever held. The works were then comparatively disorganized, and his first labor was to bring them into a good condition for the manufacture of pipe, fittings, pipe-cutting machinery, gas works appliances, and the other specialties of the company. When this was done, he systematized all these products, placing this part of the business on an excellent footing, and designed and built new additions to the works.

One of the novel features introduced by Mr. Briggs in the construction of gas holders was the flat-top holder without interior trussing. The first structure of this type was built by him for Lewiston, Me. This method of construction, now recognized as being correct, was strenuously opposed and ridiculed at the time by many engineers and prominent builders of gas holders.

In 1866 he visited Europe for the company and made the acquaintance of many foreign engineers, especially in England, where his wide knowledge of American engineering works made him a welcome visitor in professional circles. When his connection with the Pascal Iron Works was terminated in 1869, he revisited England and increased his knowledge of English practice and widened the circle of friends he made on his previous stay in that country.

Early in 1871, he became Engineer and Superintendent of the Southwark Foundry, then owned by Henry G. Morris, M. Am. Soc. C. E. Here he designed and built many large pieces of machinery, including a pumping engine for the city of Lowell, Mass., which had a remarkably good duty for that time, sugar machinery, gas apparatus, blast furnace fittings, boilers, engines and similar heavy work. He designed and built a large foundry during his connection with Mr. Morris, and a 30-ton traveling power crane. He remained in this position until the closure of the works in 1875 on account of the disturbance of the iron market at that time.

After a long illness which attacked him in 1875, Mr. Briggs made a short trip to England, returning to this country the next year to become editor of the *Journal* of the Franklin Institute, a post for which his wide experience and readiness as a writer made him particularly fitted. His work was well performed, but he wearied of it in a few years, and in 1878 opened an office in Philadelphia as a consulting engineer. This was not very profitable to him, but gave him time to prepare a number of valuable articles on technical subjects.

In 1880, he became Consulting Assistant to Col. William Ludlow, who was then in charge of river and harbor improvement in the vicinity of Philadelphia. He also retained his private practice, and was particularly interested in matters pertaining to heating and ventilating.

His health, never strong, began to fail noticeably in a short time, and late in 1881, after a brief visit to England, symptoms of paralysis appeared. He continued to work until April, 1882, when his physician

made him desist and go to his mother's home in Dedham, Mass. His vitality was too exhausted, however, for him to recover, and he died there of paralysis on July 24, 1882, after a long and painful sickness.

The professional attainments of Mr. Briggs have been described as follows by Mr. Henry R. Towne, an intimate acquaintance.

"One of his most notable traits was the comprehensive scope of his knowledge, which covered almost the entire field of engineering, both civil and mechanical, and included much also of metallurgy, chemistry, architecture and the applied sciences. On almost any topic under these many heads he could discourse as a master with a minuteness and familiarity astonishing to any but those who knew what an extraordinary range was covered by his own personal experience in connection with mechanical and industrial operations, and who knew also how far these were supplemented by professional study and reading, continued uninterruptedly during the forty years of his business life. Added to these were advantages of a good early education and exceptional aptitude for mathematics, in which he excelled, and a very retentive memory."

Personally, Mr. Briggs had an even, quiet disposition, and a remarkable faculty for making and retaining friendships.

He was elected a Member of the American Society of Civil Engineers on October 19th, 1870.

ROBERT LINAH COBB, M. Am. Soc. C. E.*

DIED JUNE 2D, 1895.

Robert Linah Cobb was born at Cumberland Iron Works, Tenn., on March 5th, 1840. He was educated in the local schools and at Stewart College, now the Southwestern University, and after the completion of his studies, became a rodman on the Memphis, Clarksville and Louisville Railroad, now part of the Louisville and Nashville-system. He soon became Assistant Engineer on this road, and in 1859 and 1860 was City Engineer of Clarksville, Tenn.

On the outbreak of the war he offered his services to the Confederacy and was assigned to the ordnance department. He was ordered to Fort Donelson, and, after the surrender of that post, reported to General Johnson at Nashville. Captain Cobb was then assigned to the engineering department and ordered to Corinth. The service he rendered as a military engineer was characteristic of the man, always faithful, painstaking, tireless and courageous. He was never taken prisoner, and served continuously until the close of the war.

* Memoir prepared by E. C. Lewis, M. Am. Soc. C. E.

After the completion of this experience, he became Division Engineer of the Memphis, Clarksville and Louisville Railroad, and in 1867 was appointed Chief Engineer of the Winchester and Alabama Railroad, now part of the Louisville and Nashville system. Two years later he became Assistant Engineer of the Memphis and Ohio Railroad, from which he went in 1869 as Division Engineer to the Memphis and Little Rock Railroad, where he remained until 1872, serving part of the time as Acting Chief Engineer. In 1873 he conducted mining operations at Kellogg, Ark., and later in Mexico, but returned to railroad work in 1876 as a member of the engineering staff of the Little Rock and Fort Smith Railway. In 1881 and 1882 he was Chief Engineer of the Texas and St. Louis Railway, now the St. Louis, Arkansas and Texas. The next four years were spent in manufacturing machinery at Little Rock, Ark. In 1886 Captain Cobb was appointed Chief Engineer of the Indiana, Alabama and Texas Railroad, and upon the absorption of that line in 1887 by the Louisville and Nashville Railroad Company, he was retained by the latter company as Chief Engineer of construction, a position he held at the time of his election as a Member of the American Society of Civil Engineers on January 2d, 1890. In this year he was appointed Chief Engineer of the Clarksville Mineral Railroad, and in 1892 went to Ohio as the Chief Engineer of the Ohio Southern Railroad. Upon the completion of his work on this line he removed his headquarters to Cleveland, where, in the winter of 1894, he had an attack of grip from which he never recovered. He returned to the South in May, 1895, and died on June 2d at his early home, Clarksville.

His life's work speaks for him professionally. Personally he was at once a loyal friend and a chivalrous foe. He was married in 1877, and was left a widower ten years later. One son survives him.

ZERAH COLBURN, M. Am. Soc. C. E.*

DIED APRIL 26TH, 1870.

More than a generation has passed away since the brilliant career of Zerah Colburn closed prematurely in the snow-covered orchard at Belmont, Mass. It is somewhat difficult, after the lapse of six and twenty years to recall with accuracy or consecutiveness the details of his feverishly busy life, and still more difficult to find authentic records,

* Memoir prepared by James Dredge, Esq.

which are more valuable than personal reminiscence. On the other hand, viewed in the perspective given by time, the errors that wrecked his life assume their proper proportions, and have ceased to tarnish the great qualities that made Zerah Colburn one of the famous engineers of his period. The curious autobiography of the earlier Zerah Colburn, published in 1833, throws some light upon the status of his family. With two exceptions it was of very ordinary stuff; the paternal grandfather was a needy unsuccessful farmer in New England; his wife a woman of strong intellect and sound judgment, who kept the home together and brought up a family, while he was seeking fortune in Europe by the exhibition of the extraordinary powers of calculation possessed by one of his children, the only member of the family who was fit for better things than the routine of farm labor. This was the first Zerah Colburn, who apparently gained more celebrity in Europe than in his native country. It is remarkable that the wonderful gift he enjoyed brought him so poor a result; in quite early life he became a minister of some dissenting denomination, and we hear no more of his calculating powers. The second Zerah Colburn, the subject of this sketch, was the son of one of the calculating Zerah's brothers, who lived and died unknown. The younger Zerah was born in 1832, shortly after his uncle had become a preacher, and when the honors of his calculating prowess were still thick upon him. Besides the name, Zerah Colburn inherited a vein of genius from his uncle, though of a different nature and tending to a more useful purpose. The farm which was his birthplace was in Saratoga, N. Y. Here his earliest years were passed, almost devoid of education, and filled with monotonous labor. But very soon—probably before he was ten years old—his extraordinary force of character and precocious development had revealed to him that the possibilities of a great future lay before him. Whence came the strong bent towards mechanics is as deep a mystery as the source from which his uncle's mathematical powers were derived, but it forced him onward, first to some local cotton mill, and afterward to the shops of the Concord Railroad, where the then superintendent, Mr. Minot, gave him his first chance, by which he profited so well that he speedily became a person of some importance on the railway.

Colburn must have stayed some years with Mr. Minot, probably three or four, but he left him in order to enter the Tredegar Locomotive Works at Richmond, Va. I believe, indeed, that there was an intermediate stage in his career, though a rather brief one. This was a short stay at some locomotive works in Boston, during which time he so far qualified himself, and so gained the confidence of capitalists, that before he was twenty-one he was a managing partner in the Tredegar Works. That he should have traveled so fast on the road to success was indeed marvelous. He was without education, except

what was self-acquired; he had no influence and only self-made friends, and the lack of steadfastness in purpose, which proved in the end his ruin, was already making itself felt. But he possessed unlimited belief in himself, his power of absorbing and retaining knowledge appeared unbounded, he possessed an apparently inexhaustible store of physical strength, and he owned these qualities to such a degree that almost to the close of his life they more than counterbalanced the disadvantages of circumstance and character.

With the termination of his connection with the Richmond Locomotive Works, Colburn's practical career came to an end, and when he was little more than two and twenty he had entered on the new path which he followed more or less fitfully to the end of his life. This was the career of technical journalism. In 1851 the engineering profession had no press worthy of the name, and Colburn realized that therein there was a great future for him. He had already made successful experiments in this direction; when he was only fourteen or fifteen years of age he had written and published (finding the means somehow, as he always contrived to do) a monthly magazine devoted to engineering subjects; it was but a small, poor thing, but nevertheless it contained the germs of the marvelous engineering press of to-day. This publication, under the name of *Monthly Mechanical Tracts*, had but a short existence, and had become extinct before he left Mr. Minot, about 1849. Afterward he contributed to the *American Railway Times* of Boston, and later to the *American Railway Journal*, of which he was for some time assistant editor. But these efforts were only experimental, and in 1854 he commenced an engineering journal on his own account under the title of the *Railroad Advocate*. This, in the course of a short time, he developed into a relatively great success, so much was it impressed with the genius of its powerful editor. But it was impossible for Colburn to work steadily for any length of time; he had made his mark as an original thinker, an able engineer and a powerful journalist, but, having achieved these things, he tired of his enterprise, and sold it to Alexander L. Holley, who had not then risen into fame, and who had the fancy of owning and editing an engineering paper. The venture was not profitable, except for Colburn, and the journal dragged on a languishing existence for about 18 months, during which Colburn was a frequent contributor, at the same time attempting the utterly uncongenial and unsuccessful attempt to establish himself as a commercial engineer.

The summer of 1857 saw him in Europe, and on his return he bought back an interest in the *Railroad Advocate*, changed the name to the *Railway Engineer*, and conducted it with Holley for a year longer, when it died. He had returned to Europe in the fall of 1857 on a special mission, the work and pleasures of which he shared with Holley; at this time Colburn was not twenty-six years of age, Holley

being a little his senior. These two brilliant young men visited Europe at the request of several leading American railroads with the purpose of reporting on English railway practice. The visit proved to be a turning point in Colburn's life; it terminated—with a few fitful exceptions—his residence in the United States, and made England his future home. Returning to America in the fall of 1857, he and Holley, in an incredibly short time, produced what was for a long time a standard book on European railways. In 1858 Colburn was back in London, and during the summer of that year he became editor of *The Engineer*, of London, a journal that had been started and feebly conducted for a few years. Colburn's energy, skill and brilliant qualities soon impressed themselves on the paper and raised it into a strong position, but he tired of the work, and returning to America in 1860, started a paper in Philadelphia on his own account, and bearing the same title, *The Engineer*. After five months this was abandoned, and the next year he returned to London, and was gladly received again as editor of *The Engineer*. This position he retained longer than any other during his life, for he did not finally quit his active work as its editor till 1864.

Then followed a period of general engineering practice and the preparation for the final venture of his life, the establishment of *Engineering*. The first number of this journal appeared in the beginning of January, 1866, and during the next sixteen months almost every page bore the stamp of his energy and genius. With the opening of the Paris International Exposition of 1867 he once more, and for the last time, fell away from the path of usefulness and work, and a record of the next four years would be but a melancholy story, relieved by occasional flashes of light, sufficiently brilliant, however, to prove that his great powers remained unaffected to the last. The facts may be stated now after so many years. Colburn's besetting weakness, or rather his incurable disease, was one before which many full of talent, like De Quincy and Edgar Allan Poe, had fallen before his time.

During the brief years into which Colburn's active career must be compressed, he achieved a high and lasting reputation, and it may in all justice be claimed for him that he was the creator of engineering journalism. It is believed that the following list of his life's literary work is a fairly complete one; it is compiled to a large extent from his own memoranda:

- 1847.—Wrote *Monthly Mechanical Tracts*, published at Lowell.
- 1848.—Wrote *The Locomotive Engine*, published in Boston.
- 1851-53.—Was contributor to the *Boston American Railway Times*.
- 1852.—Was contributor to the *Carpet Bag*.
- 1853.—Became assistant editor of the *American Railroad Journal*.
- 1854.—Started, as editor and proprietor, the *Railroad Advocate*.

- 1856.—Sold the *Railroad Advocate* to A. L. Holley and attempted several things, contributing at the same time to the *Railroad Advocate*.
- 1857.—Visited Europe, and on his return bought an interest in the *Railroad Advocate*.
- 1857.—Second visit to Europe; this time with Holley to report on European railway practice.
- 1858.—Published, with Holley, "The Permanent Way and Coal-Burning Locomotive Boilers of European Railways."
- 1858.—Wrote the American section of D. K. Clark's book on "The Recent Practice in the Locomotive Engine."
- 1858.—Became editor of *The Engineer*, London.
- 1860.—Published an essay on "Steam Boiler Explosions" (John Weale & Sons).
- 1860.—Started, as editor and proprietor, *The Engineer*, Philadelphia.
- 1861.—Became editor of *The Engineer*, London, for the second time.
- 1863.—Wrote "An Enquiry into the Nature of Heat," published by Spon.
- 1863.—Wrote paper for the Institution of Civil Engineers "On American Iron Bridges."
- 1863.—Wrote paper for the London Society of Engineers "On the Relation Between the Safe Load and the Ultimate Strength of Iron."
- 1864.—Published "Gas Works of London" (Spon).
- 1864.—Wrote a part of "Locomotive Engineering." (This was published by Collins & Co., of Glasgow, but was not finished by Colburn.)
- 1864.—Resigned the editorship of *The Engineer*.
- 1864.—Read a paper, "A Description of the Harrison Steam Boiler," before the Institution of Mechanical Engineers.
- 1865.—During this year Colburn was a contributor to *The Engineer*, and he wrote and read the following papers: "On Certain Methods of Treating Cast Iron in the Foundry" (Society of Engineers); "On the Ginning of Cotton," and "On the Manufacture of Encaustic Tiles, etc., by Machinery" (Society of Arts).
- 1866.—Founded London *Engineering*.
- 1869.—Read papers "On American Locomotives and Rolling Stock" before the Institution of Civil Engineers; and a second, "On Anglo-French Communications," before the Society of Arts.

Zerah Colburn was a member of several institutions, among others of the American Society of Civil Engineers, of the London Institution of Civil Engineers, of the Institution of Mechanical Engineers, and of the Iron and Steel Institute; he was also a President of the London Society of Engineers. He was elected a Member of the American Society of Civil Engineers on January 5th, 1855.

ADDISON CONNOR, M. Am. Soc. C. E.*

DIED JANUARY 4TH, 1891.

Addison Connor was born in New York City on April 2d, 1847. He was a graduate of Tufts College and of the Massachusetts Institute of Technology, and later in his life was given the degree of M. A. by the former institution. From 1871 to 1873 he served as assistant in the office of a Boston engineer, and then became transitman on the works for an additional water supply for the city of Boston. This position he held for seven years, when he became an assistant to Clemens Herschel, M. Am. Soc. C. E., and was engaged on surveys and tests of hydraulic machinery in the neighborhood of Holyoke, Mass.

In 1881, he became Resident and Assistant Engineer on the Northern Pacific Railroad, and built the company's dock at Superior, Wis., a structure 1 000 ft. long and 166 ft. wide. He was then transferred to the Missoula Division in Western Montana, and afterwards to the Cascade Division. When work on this railroad was suddenly suspended in 1884, he came east and entered the Department of Public Works of New York City as Assistant Engineer. Two years later he left this position to go to Plattsmouth, Neb., where he was employed by George S. Morison, M. Am. Soc. C. E., on surveys of the Missouri River at that place. He spent about seven months in 1886 and 1887 at Nebraska City, being engaged on preliminary surveys for the rectification of the river and the location of the bridge subsequently built there. He left Nebraska City early in June, 1877, to become one of the assistant engineers on the Cairo Bridge. Shortly before the completion of this bridge he was transferred to St. Louis, where he was engaged on some city work in connection with the new line of the St. Louis, Keokuk and Northwestern Railroad into that city. On the completion of his work there, he left Mr. Morison's employ, and in 1890 was appointed Assistant Engineer in the Department of Docks of New York City, where he remained until his death, which occurred January 4th, 1891.

Fidelity to duty was one of Mr. Connor's conspicuous traits. Modest and unassuming, although well equipped in his profession, the uniform reliability of his engineering work in various branches had gained for him the implicit confidence of those who employed him and who will remember kindly his able and conscientious collaboration.

Mr. Connor was elected a Member of the American Society of Civil Engineers on January 5th, 1887. He was married in 1876 to Mary E. Childs, of Framingham, Mass., who survived him.

* Memoir prepared from information furnished by George S. Morison, A. Fteley and Fred. Brooks, Members Am. Soc. C. E., and from papers on file at the House of the Society.

ECKLEY BRINTON COXE, M. Am. Soc. C. E.*

DIED MAY 13TH, 1895.

Eckley Brinton Coxe, born at Philadelphia on June 4th, 1839, came of a family long identified with American history. In the last decade of the seventeenth century, one of his ancestors, Dr. Daniel Coxe, of London, purchased a patent granted originally by Charles I and covering the territory between the 31st and 36th parallels, and from the Atlantic to the Pacific, which was exchanged by his grandchildren for 100 000 acres in New York. He also had large holdings in New Jersey, and did much to build up trade in that colony. Dr. Coxe spent most of his life in London, but his son, Col. Daniel Coxe, lived in America from 1700 until his death in 1739. He took a prominent part in local political matters, and was a Judge of the New Jersey Supreme Court. His son, William Coxe, was a merchant in Burlington, N. J. The son of William Coxe, Tench Coxe, was a well-known figure in public affairs during the early history of the United States. He held several national offices and devoted much time to encouraging the growth of cotton, and it was to his recognition of the value of the Pennsylvania coal beds that the present mercantile position of the Coxe family is largely due. He formed a partnership with some acquaintances and acquired some of this coal land. His son, Judge Charles Sidney Coxe, bent most of his energies to extending and uniting this coal property, and when he died, in 1879, the great estate was in an excellent condition, financially and legally.

Just as Judge Coxe had his life work laid out by the affairs left him by his father, so did his children find their labors were outlined by the family coal properties. Eckley B. Coxe, one of these sons, soon became prominent as their technical administrator, and his engineering knowledge and experience made him one of the foremost mining engineers of his time.

He graduated from the University of Pennsylvania in 1858, and subsequently took a post-graduate scientific course there. His early knowledge of practical engineering matters was acquired during the summers spent on the family coal lands, where he was often a member of surveying parties. He thus became acquainted with the details of mining and preparing coal, and also of the topographical and geological features of the great property, so that when he began his technical studies, their practical import was apparent to him from the outset.

His progress in the European schools was excellent. At the École Nationale des Mines in Paris, where he remained for two years, he is

* Memoir prepared from papers on file at the House of the Society.

still remembered, and his interest in that institution throughout his life was marked by many donations to it. At Freiberg he became well acquainted with Prof. Julius Weisbach, and published a translation of a portion of the latter's text-book on mechanics, which has long been recognized as an engineering classic.

In 1864, he returned to the United States. He was then twenty-five years of age and possessed of a wide theoretical knowledge of the principles of mining engineering. The great coal properties of the family estate were then worked in part under leases held by large operators, and Mr. Coxe quietly went about to acquire these leases, so that the entire output of the property would be under the control of its owners. Such a task was naturally a difficult one, but it was gradually accomplished. The Cross Creek Coal Company, of which Mr. Coxe was president, was organized to manage the mining operations. The Delaware, Susquehanna and Schuylkill Railroad Company, owned by the members of the Cross Creek Company, was organized to give the collieries of the estate an independent railway connection with the Pennsylvania, New Jersey Central, Reading and Lehigh Valley systems, so that the transportation of coal to the seaboard was not confined to a single line. A selling agency, Coxe Brothers & Company, was incorporated to market the coal, and built docks at Perth Amboy, Buffalo, Milwaukee and Chicago. The Coxe Iron Manufacturing Company was organized to carry out the construction and repair of the mining and railway machinery of the allied companies, and also took large outside contracts for machinery.

As the president of all these companies Mr. Coxe was naturally a busy man, yet he found time to give personal attention to many other matters. The welfare of his employees and their families engaged his attention to a marked degree, and insurance funds, schools and other evidences of his regard for his men have been frequently described by his biographers. It is characteristic of the man that even when labor troubles were in progress, and he was the victim of sympathetic strikes, the needy families of the men who were out found relief at his home. When Franklin B. Gowen was engaged in putting down the Molly Maguire lawlessness, Mr. Coxe was his hearty supporter and shared in his personal danger during those troublesome times.

Mr. Coxe was a Democrat in politics, but while he took an interest in public affairs, he was not personally active. He was elected a State Senator at one time, but had conscientious scruples against taking the oath of office, and did not occupy his seat until re-elected by an overwhelming majority.

He was an ardent believer in technical education and was a Trustee of Lehigh University from its beginning. In one of his last letters he wrote to a friend that he was living for two things—this university and the utilization of small coal. As a member of the Pennsylvania State

Commission on "Waste of Anthracite Coal" and of the Commission in charge of Second Geological Survey of Pennsylvania he did much work, and aided the investigations of these important commissions with a lavish expenditure of time, money and privately acquired data. In recent years, his experiments looking towards the utilization of small coal have attracted much attention, and his apparatus for preparing and burning it have been described frequently.

Mr. Coxe was elected a Member of the American Society of Civil Engineers on February 7th, 1877. He was one of the founders of the American Institute of Mining Engineers, and was actively engaged in its management during twelve of the twenty-five years of his connection with it, which terminated only at his death. He was President of the Institute in 1878 and 1879, and held the same office from 1892 to 1894 in the American Society of Mechanical Engineers. He was also a member of a large number of other scientific and social clubs in this country and abroad.

Mr. Coxe died of pneumonia on May 13th, 1895, after a short sickness, and was buried in a little churchyard within a stone's throw of his offices in Drifton. His wife, an invalid for many years, two brothers and a sister, survive him.

HORACE LAFAYETTE EATON, M. Am. Soc. C. E.*

DIED NOVEMBER 23D, 1895.

Horace LaFayette Eaton was born in Boston, Mass., on September 6th, 1851. In 1869 he entered the office of the City Engineer of Boston as rodman, and subsequently became transitman, leveler and Assistant Engineer. He was employed at one time or another on all branches of work done under the direction of the City Engineer, both in the field and in the office, so that when he was elected in 1887 to the position of City Engineer of Somerville, he was well qualified for his duties.

Mr. Eaton had the reputation of being a very careful and cautious engineer and a man of strict integrity. All of his plans were worked out with a thorough regard for every detail. In the execution of all the public work constructed under his supervision he required honesty and faithfulness, and no work which was not up to the standard was accepted. False stories were ingeniously circulated by Mr. Eaton's enemies, and were used by certain cheap politicians who wished to control the office for their own purposes, and finally the City Council

* Memoir prepared by Desmond Fitzgerald, M. Am. Soc. C. E.

was induced to order an investigation into the affairs of the City Engineer's office.

The first hearing had been held, and his enemies had told their stories, all of which were printed in a sensational manner by the newspapers, before he had an opportunity to make any defence. Mr. Eaton, already overworked, was harassed and despondent. The false statements made in public so worked on his sensitive nature that, in a fit of temporary insanity, he took his own life.

The act came as a terrible shock to the community. The people of Somerville were sad and indignant, and requested the City Council to continue the investigation. It was carried on after his death in a most searching manner, the result being that Mr. Eaton was completely exonerated from every charge, and those making the false accusations were denounced for having brought them against an innocent man without any facts on which to base them.

Mr. Eaton was elected a Member of the American Society of Civil Engineers on February 1st, 1893. He left a wife and two children.

JOHN ROBERTS GILLISS, M. Am. Soc. C. E.*

DIED JULY 15TH, 1870.

John Roberts Gilliss was of Maryland ancestry, and was born in Washington, D. C., January 4th, 1842. He was the second of three sons of Capt. James M. Gilliss, U. S. N., who, as Lieut. Gilliss, conducted a U. S. naval astronomical expedition to the southern hemisphere in 1849-52, the results of which were published in an elaborate work as an executive document of the 33d Congress, and who, at time of his death in 1865, was in charge of the Naval Observatory at Washington.

The son, John R. Gilliss, had an unusually precocious intellect. His brain was large compared with his body, which was slight and delicate, although his appearance and bearing were in advance of his years. He received his education at a classical school in Georgetown, D. C., graduating at the early age of fifteen, when his teacher told his parents he could take him no farther in mathematics, and presented him with the only gold medal ever given in the school. Being very proficient in this study, he was, while yet a boy, a useful assistant to his father in astronomical computations.

In 1857 he went to Peru with W. W. Evans, M. Am. Soc. C. E., to take the place of Rodman on a railroad then being constructed under the direction of that noted engineer. In a short time, although but

* Memoir prepared by G. B. Nicholson, M. Am. Soc. C. E.

sixteen years of age, he was promoted to the charge of a section of 16 miles under construction.

Returning to the United States, he entered the service of the Coast Survey as Aid, and afterwards was engaged during the greater part of the Civil War as a civilian assistant in the Engineer Department of the Army. From 1863 to July, 1865, he was principal Assistant Engineer to Lt.-Col. J. H. Simpson, Chief Engineer of the Department of the Ohio, being engaged all that time on the construction of fortifications in Kentucky. He had charge of the completion of those at Camp Nelson, and designed and built those at Frankfort and Louisville.

At the close of the Civil War, an engineer bureau was organized by the Secretary of the Interior to take charge of the Government interests in the Pacific railroads, and conduct the work of a number of wagon roads in the territories which Congress had placed in care of that department. Mr. Gilliss was made Principal Assistant, July, 1865, under the head of the bureau, Lt.-Col. Simpson, and rendered valuable aid in the preparation of the interesting report of his chief published in 1865. The discussion on the limiting effect of grades on railroads found in that report was conducted by Mr. Gilliss and was one of the earliest contributions to that subject published.

Desiring further experience in railroad engineering, he took a position in August, 1866, as Assistant to L. M. Clements, Resident Engineer of the Central Pacific Railroad, in the Sierra Nevadas, the work of Mr. Gilliss being principally on the tunnels of that section. A description of the tunnels of the Pacific railroads is found in a paper he read before the Society on January 5th, 1870.*

Having finished his work on the Central Pacific Railroad, he was employed as Engineer in charge of construction on the Union Pacific Railroad, between Wasatch and Castle Rock, on the completion of which he returned to New York, and was engaged on a pneumatic tunnel project in that city, which was never brought to a successful conclusion. He died suddenly of apoplexy of the brain at the home of his mother at West New Brighton, Staten Island, July 15th, 1870, aged 28 years.

Mr. Gilliss was elected a Member of the American Society of Civil Engineers on June 2d, 1869, and a Fellow on March 15th, 1870. He was versatile in his talents; it is not out of place to say, genius. A man of fine executive ability, he had the happy gift of commanding men without his subordinates realizing they were commanded; a charming companion, gentle and unobtrusive in manner, but nevertheless dignified; a constant reader of the best literature, and, while disclaiming that he was a mathematician, often reading works of pure mathematics with as much interest as others would fiction; and notwithstanding his mathematical bent, he had a large artistic talent.

His early death prevented his name from acquiring the renown as an engineer which was so largely promised.

* See *Transactions*, Vol. I, p. 153.

WILLIAM HARRISON GRANT, M. Am. Soc. C. E.*

DIED OCTOBER 12TH, 1896.

William Harrison Grant died at his home in Sing Sing, N. Y., Saturday, October 12th, 1896, aged eighty-one years and five months, having been born May 15th, 1815. He was descended from William Grant, a revolutionary soldier who was pensioned for his services in both the army and the navy.

When nineteen years old, Mr. Grant entered the New Paltz Academy, where he studied mathematics and surveying. He began practice in country surveying and on the New York and Erie Railroad, after which he went to Ithaca Academy to continue his mathematical studies and complete his education. Soon after leaving the academy he was appointed Assistant Engineer on the enlargement of the Erie Canal under William J. McAlpine, where he remained some eight or nine years. During intervals in his canal service, he spent two winters in the Legislature at Albany as Deputy Clerk, and also acted as assistant to Adjutant General Niven. Later he was employed as Assistant Engineer on the Hudson River Railroad survey under John B. Jervis, and before that road was completed, he was appointed Chief Engineer of the Cleveland, Zanesville and Cincinnati Railroad, of which he constructed 60 miles. He was then called to Washington, D. C., and took charge of a railroad survey from Georgetown to Hagerstown, Md. This road was not built at the time, but the surveyed route was afterwards occupied by the Baltimore and Ohio Railroad.

Returning to New York, he was appointed Superintending Engineer of Central Park, and was connected with the work until its completion. In later years, he looked back upon this portion of his professional career with the greatest pride. Following his connection with Central Park, he was appointed Superintending Engineer of the Department of Public Works of New York City, his charge embracing the annexed district, across the Harlem River, now the 23d and 24th Wards of the city. He afterwards became Constructing Engineer of the Department of Public Parks. In 1876 Mr. Grant formed a partnership with Donald G. Mitchell, as landscape architects, but in a year or two he accepted an appointment from the general government on the improvement of rivers and harbors in Maryland and Virginia.

Mr. Grant had a large and varied experience in engineering work, and in addition to the engagements already noted, there were terms of service upon the Eastern Division of the Ontario and Western Railroad, and the northern half of the West Shore Railway. He also furnished the plans and constructed in part the Yonkers system of water

* Memoir prepared by Alfred P. Boller, M. Am. Soc. C. E.

works. His last public place was as Superintendent of the new United States Naval Observatory, Mr. Richard M. Hunt, architect. On the near completion of the several buildings under his charge, he resigned his position, retiring in 1893 from the active practice of his profession, and passing the remainder of his life at Sing Sing, N. Y.

Mr. Grant was one of the early members of the American Society of Civil Engineers, which he joined on July 2d, 1873. In early life he married Miss Mary Locke, of Sing Sing, daughter of James Locke, and sister of Rev. Dr. Clinton Locke, of Grace Episcopal Church, Chicago. She survives him, together with three children: Dr. Frank S. Grant, of New York City; Mrs. James E. Childs, wife of the General Manager of the Ontario and Western Railway, and Miss Teresa Grant. Mr. Grant was one of the very last of the old-school engineers, with whom engineering was wholly a development from subordinate field positions. In their youth the technical school was unknown, and there was no engineering literature to draw upon. They were bold and resourceful men, who accomplished much in their day and generation, and paved the way well for the great later-day triumphs of the profession.

The probity of character that attached to these men was highly marked in Mr. Grant, whose uncompromising integrity was one of his strongest characteristics, although coupled to a most kindly disposition.

ROBERT G. HATFIELD, M. Am. Soc. C. E.*

DIED FEBRUARY 15TH, 1879.

Robert G. Hatfield, born at Elizabeth, N. J., in 1815, began his career as a carpenter and builder. He was of a studious nature, and soon fitted himself to be an architect. He designed a number of structures, chiefly warehouses and shops, but achieved his reputation as an architectural engineer. His designs for complete buildings have been criticized as not highly artistic in character, but sometimes very ingeniously planned and always well executed. In the technicalities of his profession, however, he was regarded as a recognized authority, and as his spare time for some years was spent in making experiments on the strength of building materials with a testing machine of his own invention, he acquired a large amount of data on this subject. He was a painstaking investigator of matters relating to the computation of stresses, and among his books is one on "The Theory of Transverse Strains and its Application in the Construction of Buildings." In this book are a large number of original tables based on the results of his

* Memoir prepared from papers on file at the House of the Society.

investigations. An account of some of his experiments with stones of various classes is given in a paper presented by him to this Society at its fourth annual convention and printed in the second volume of *Transactions* under the title of "Experimental Tests of Building Stones." Among his earlier books was one entitled "The American House Carpenter," which had a considerable sale fifty years ago.

As a designer of structural work, Mr. Hatfield was frequently consulted by other architects, his best known work probably being the arched roof of the Grand Central Station at New York City. He was also frequently retained as a referee in disputed subjects, and was employed by Andrew H. Green, when Comptroller of New York, to estimate the value of the work actually done on the County Court House in that city by the contractors in the Tweed ring.

Mr. Hatfield was elected a Member of the American Society of Civil Engineers on December 4th, 1867. He was one of the earliest members of the American Institute of Architects and an earnest worker in advancing its growth and influence. He gave up much time to its affairs, acting as Treasurer for many years and serving as President of the New York chapter for some time. Among his papers presented to that body were two advocating improvements in construction tending to diminish danger from fires, a subject to which he paid much attention.

Mr. Hatfield died in Brooklyn on February 15th, 1879.

NORMAN JAMES NICHOLS, M. Am. Soc. C. E.*

DIED APRIL 8TH, 1896.

Norman James Nichols was born in Essex, Vt., December 3d, 1835. He graduated from the Chittenden County Institute at that place in 1858, having taken a course in engineering, and intended to go West immediately to engage in railroad work. These plans had to be abandoned, however, and until 1862, he was engaged as carpenter and building contractor in Essex and neighboring towns. In August, 1862, he enlisted with the Second Vermont infantry and served in many severe engagements, being wounded at the Wilderness. In May, 1865, he was honorably discharged, and began work again as a contractor for buildings and highway bridges in Essex. He followed this business for about eight years, with occasional intermissions during which he was engaged as draftsman or superintendent in manufacturing establishments.

In the winter of 1873-74 Mr. Nichols moved to Worcester, Mass., and became associated with the firm of Buttrick & Wheeler, with

* Memoir prepared from papers on file at the House of the Society.

whom he remained for three years. This firm had a general engineering practice at that time, and was engaged in laying out the sewerage, sewage disposal and water systems for the large State Lunatic Asylum in Worcester; surveys for extensions of the Worcester and Shrewsbury Railroad; the location of the Connecticut Valley Railroad, a narrow-gauge line from New Haven, Conn., to Turners Falls, Mass., and general city surveying. In 1878, Mr. Nichols was in charge of the construction of a water-power dam at Cherry Valley, Mass., to replace a structure destroyed by the Lynde Brook Reservoir disaster, which forms the subject of a report in *Transactions*, Volume V, page 244.

In February, 1879, Mr. Nichols went to the Republic of Colombia to take part under Daniel M. Wheeler in the surveys and construction of the Magdalena Railroad, about 30 miles long, connecting the navigable reaches of the Lower and Upper Magdalena River around the falls at Honda. In about a year the company engaged in the work failed, and he returned to the United States. In July, 1881, he was engaged by F. J. Cisneros, M. Am. Soc. C. E., to take the place of an engineer retiring from the staff working on the Antioquia Railroad, a 125-mile line from Puerto Berrio to Medellin, and was soon appointed Chief Engineer of that undertaking. From April, 1882, to May, 1886, he was Chief Engineer of the La Dorada Railroad, and afterward, up to the time of his death on April 8th, 1896, was engaged in general engineering and mining work in the vicinity of Honda, Republic of Colombia.

Mr. Nichols was elected a Member of the American Society of Civil Engineers on December 5th, 1888.

ALBERT FRANKLIN NOYES, M. Am. Soc. C. E.*

DIED OCTOBER 12TH, 1896.

Albert F. Noyes, son of George H. Noyes, was born in South Boston in 1850. The family removing to Melrose, he was educated in the public schools at that place, and prepared for his special career at the Lawrence Scientific School of Harvard University, Cambridge, Mass. From July, 1871, to November, 1873, he was an Assistant in the office of Ernest W. Bowditch, Jun. Am. Soc. C. E., and Mr. Charles H. Bateman, engaged chiefly on topographical surveying and landscape architecture. Subsequently he was Principal Assistant to Mr. Frederic Schoff, City Engineer of Newton, Mass., and from March, 1875, to February, 1876, was Acting City Engineer of that place.

* Memoir prepared by H. D. Woods, M. Am. Soc. C. E.

He was appointed City Engineer of Newton in February, 1876, and filled that position for seventeen years. During this long term of office the development of the city constantly increased the demands made upon the office. Besides having charge of all the city surveying, making all plans for public works, the City Engineer had the laying out of all works on the highways and had to keep the accounts of all highway expenses, and was engineer of the Water Board. In 1882 he was appointed Plumbing Inspector for the Board of Health, which position he filled for several years, remodeling the plumbing regulations. In 1882-83 he was called upon by the Public Property Committee to make a sanitary survey of all the school houses, and designed and executed plans for heating and ventilating several of the old buildings. He mapped out a proposed plan for a 376-acre park in the central part of the city. He inaugurated a system of highway accounts, whereby the actual cost of each class of work was kept distinct, thus enabling him to make accurate estimates of any work proposed to be done by the Department. In 1884 he made a sanitary inspection of the city with reference to sewer requirements, and in 1887, with members of the city government, visited the separate system of sewers as constructed in various towns and cities in New Jersey and Pennsylvania, also Pullman, Ill. In 1890 he made a comprehensive report on a separate system for the city of Newton, which included 130 miles, estimated to cost \$1 750 000, or an average of \$2 56 per foot. The system was adopted and construction commenced the following year, over 40 miles being built under his administration. In 1889 in connection with Alphonse Fteley, M. Am. Soc. C. E., as Consulting Engineer, he made a report on the additional water supply for the city of Newton, and also on a high-service system. In 1892 the additional supply work was carried out by building a covered filtering conduit and the first covered masonry reservoir in this section of the country. In 1892 in connection with Mr. Edward Buss, he made an exhaustive report on a system of surface drainage for the whole city, which included the improvement of the various brooks, forming a series of parkways through the city. Nearly one mile of Cheese Cake Brook was straightened and deepened and laid out with drives on either side under this proposed improvement. Early in 1893 in connection with Charles A. Allen and George S. Rice, Members Am. Soc. C. E., he reported on a plan for abolishing the various crossings on the Boston and Albany Railroad through the city. Plans for several miles of boulevard 120 ft. wide were prepared the same year, but, owing to legal questions, actual work was not begun during his administration.

On July 24th, 1893, Mr. Noyes resigned his position as City Engineer of Newton to accept the position of Assistant Chief Engineer of the Massachusetts State Board of Health, to make a special study of the ground-water supplies of the State. During 1893, 1894 and 1895

he examined and reported on the water supply of forty or fifty places in Massachusetts. He also investigated the availability of the Ipswich and Shawsheen Rivers and the water-shed of the Charles River for a portion of the metropolitan supply. From 1886 to 1889 he investigated and reported on systems of ground-water supply for the cities of Malden and Brockton and the towns of Reading and Medford, and also on the distributing system for the Milford Water Company.

In 1894 he was appointed by the Governor a member of the Metropolitan Sewer Commission, to succeed Mr. Harvey N. Colligan. This was an especially appropriate appointment, as from its start Mr. Noyes had been conversant with the work and plans of the metropolitan sewer construction, and the requirements of the outlying districts, the city of Newton being one of the first to connect with the system. In 1895 he was elected to represent his ward in the Board of Aldermen of the city of Newton, and was appointed on the Highway Committee and Chairman of the Sewer Committee.

He closed his connection with the State Board of Health, and in February, 1895, formed a partnership with Allen Hazen, Assoc. M. Am. Soc. C. E., under the firm name of Noyes & Hazen, making a specialty of sewer and water-works investigations and construction. In the line of water supply this firm made investigations, surveys or reports for Austin, Tex.; Far Rockaway, L. I.; Menominee, Mich.; Columbus, Cleveland and Painesville, O.; Harrisburg and Du Bois, Pa.; Jersey City, N. J.; Ashland, Wis.; Indianapolis and Princeton, Ind.; Greenfield, Munson, Lynn and Adams, Mass.; and for a high service supply for Lawrence, Mass., and Hartford, N. Y. In the line of sewerage it was connected with the design or construction of sewer systems in Altoona, Pa.; Plainfield, N. J.; Vassar College, Poughkeepsie, N. Y.; Spencer, Quincy and Melrose, Mass.

Mr. Noyes showed remarkable ability and excellent judgment. He was a broad-minded public official, and a very careful, conscientious worker, adhering strictly to the course which he considered best for the city. He was a constant student, and never undertook any work without examining the subject from all sides, and ascertaining how to obtain the best results with the least expenditure of public funds. As an example of this, when the work was commenced on the Newton sewer construction, and the various pipe dealers had made a combination and fixed prices, he visited, with the Chairman of the Sewer Committee, the principal pipe yards in the Akron and Ohio River districts, St. Louis and the Potomac Valley, to ascertain the ability of the yards to furnish the material required, and to get information which would allow him to better judge the quality of the pipe required. He was able in this way to make contracts with firms outside the combination, and to get some of the best pipe that was ever used in an eastern market at a considerable saving to the city. What-

ever matters were brought to his attention were thoroughly investigated, and whatever knowledge was required outside of his own experience was carefully looked up, and the advice of the best authorities sought before settling on a definite policy.

He was generous and kind, had a pleasant greeting for everyone, and would listen patiently and attentively to all grievances brought to his attention, endeavoring to give everyone justice, and to repair all apparent wrongs which might be caused to private individuals through the carrying out of public works. By his death the city of Newton lost a valuable public-spirited official and citizen, who was ever mindful of the welfare and development of the city. The State lost a valuable adviser, and the engineering profession one of its most prominent members, he being considered one of the foremost engineers in his specialty. He was regarded as an expert in matters of ground-water supply and sewerage, his advice being sought from various parts of the United States.

Mr. Noyes was elected a member of the American Society of Civil Engineers on December 3d, 1884. He was a Member and Past-President of the Boston Society of Civil Engineers, and at the time of his death was Vice-President of the Massachusetts Highway Association. He was President of the New England Water-Works Association for the years 1890 and 1891. He leaves a widow, one son and two daughters.

HENRY WARD BEECHER PHINNEY, M. Am. Soc. C. E.*

DIED NOVEMBER 22d, 1888.

Henry Ward Beecher Phinney was born in Jay, Me., January 28th, 1854.

In May, 1875, he entered the office of Shedd & Sawyer, Civil Engineers, in Boston, Mass., as student and apprentice, and was employed on the construction of water-works at Newton, Mass., and in charge of pile-driving on the main sewer at Brookline, Mass.

From 1878 to 1882 he was employed under Howard A. Carson, M. Am. Soc. C. E., on the construction of the improved sewer system of Boston, Mass., as Assistant Engineer and Foreman, having charge of many important structures. In March, 1882, he took charge of the construction of the receiving well for the Indianapolis, Ind., Water Company, 12 ft. in diameter and 30 ft. deep, through saturated gravel on the bank of White River, under the direction of J. J. R. Croes, M. Am. Soc. C. E. On the completion of this work he was employed

* Memoir prepared by J. J. R. Croes, M. Am. Soc. C. E.

by Mr. Croes as Resident Engineer of the construction of the water-works at Princeton, N. J., and afterwards, from 1883 to 1886, as Resident Engineer of the Suburban Rapid Transit Company, having charge of the surveys and the construction of the Harlem River Bridge, and the brick and iron viaducts in Morrisania, New York City.

Pulmonary disease compelled him to resign this position on December 1st, 1886, and he went to Pasadena, Cal., where he died on November 22d, 1888.

Mr. Phinney was accurate and painstaking in all his work, and was an excellent organizer and superintendent of labor, a good draftsman and computer, and a rigid and at the same time judicious supervisor of the construction of works.

He became a Member of the Boston Society of Civil Engineers in October, 1879, and of the American Society of Civil Engineers on January 7th, 1885.

THOMAS PROSSER, M. Am. Soc. C. E.*

DIED SEPTEMBER 15TH, 1870.

Thomas Prosser was educated in England as a civil and mechanical engineer and architect, and practiced his profession for some time previous to his removal to the United States, which took place about 35 years ago. In this country he has been better known as a mechanical engineer and inventor, and was for several years engaged in the manufacture of boiler tubes.

An acquaintance which he formed with the proprietor of Krupp's celebrated steel works at Essen, Prussia, while visiting the London Exhibition of 1851, resulted in the appointment of Mr. Prosser to the American agency of those works, which he held until his decease. For several years past Mr. Prosser was the only agent remaining in position from among those who had received appointment by the personal selection of Mr. Krupp.

In the autumn of his life Mr. Prosser became a member of the American Society of Civil Engineers and Architects soon after its reorganization in 1867, his name being the tenth in order on the roll of new members.

He brought into our circle a thoughtful, inventive and methodical mind, well stored with useful knowledge, and, disciplined by long experience and culture, soon took a prominent place, and was during his entire membership thoroughly identified with the growth and welfare

* Memoir prepared by Messrs. Jacob M. Clark, John F. Ward and A. W. Craven, in 1870, but never published.

of the Society. His name is connected with many of the important business committees which have been formed, and for nearly a year preceding his decease he was a member of the Board of Direction. His duties were always assumed without ostentation, and most faithfully and punctually discharged. The minutes show that no living member has been for the same period a more constant attendant on our meetings, and his colleagues in committees and on the Board remember that his place was never vacant unless when he was detained by infirmity, and that he always came thoroughly prepared for business. His sincere convictions and thorough discipline made him a tenacious, though always courteous and manly, opponent, and as an ally, staunch and reliable.

The published *Transactions* of the Society are enriched by an interesting article from his pen, illustrating a highly ingenious method and apparatus of his invention for the conservation of heat in distillation.

Few members have bestowed a more liberal share of honest and earnest effort upon the business of the Society than Mr. Prosser.

With less of evil to "live after him" than can be said of most men, his spotless record may well be our just pride, so that the good may not be "buried with his bones."

This Committee recommends the following preamble and resolutions:

Whereas, The American Society of Civil Engineers and Architects, by decree of that Divine Power whose mandates all must obey at the appointed time, has been deprived of a valued and honored member and officer, skilful and distinguished in his calling, able and intrepid in counsel, a genial and sympathizing friend, worthy in all the relations of life; therefore

Resolved, That we tender to the surviving family and friends of the late Thomas Prosser our cordial sympathy and condolence.

WILLARD SMITH POPE, M. Am. Soc. C. E.*

DIED OCTOBER 10TH, 1895.

Willard Smith Pope was born on January 16th, 1832, in the then village of Rome, N. Y. He was the son of Dr. G. W. Pope, a physician and a man of standing in the community. His early life was spent in Rome, where he attended school and prepared for college. He entered Hamilton College, Clinton, N. Y., in 1847, and graduated

* Memoir prepared by George S. Morison, Past-President Am. Soc. C. E.

in 1851, at the early age of nineteen. After graduation he went to Buffalo, where he studied law, and was admitted to the bar after a single year of hard work. The early labor by which he had accomplished this result at a period when boys are often still at school now told upon him, and his health gave way. He left Buffalo, returned to his father's home in Rome, and spent several months in the open air, under the general care of his father.

Feeling that his health required an outdoor life, he obtained a position in the engineer corps of the European and North American Railway, and spent the fall of 1852 and the following winter in the woods of New Brunswick and Maine. This was the beginning of his work as an engineer, and he decided to abandon the law and make engineering his profession. He next spent the larger part of a year in the Astor Library in New York City, laying a theoretical groundwork for his new profession. In 1853 he went to the West, and worked for the Illinois Central Railroad on the location of its line in Southern Illinois. From there he went, in 1854, to the Galena and Chicago Union Railroad, which became the Chicago and Northwestern Railway in 1864 by a consolidation with other lines. He remained there until the latter part of 1864, and during the last four or five years he held the position of Chief Engineer.

It was while there that he was called on to do his first important work in bridge building. The bridge across the Mississippi River at Clinton was the second bridge across that river, the only earlier one being the old Rock Island bridge, the piers of which were founded on rock in shallow water. No such rock existed at Clinton, and the river was narrow and exceptionally deep. Mr. Pope used pile foundations, which have since become the standard practice on the upper Mississippi for all the piers except the pivot piers, and founded the pivot pier on a timber crib 400 ft. long, which not only carried the pier, but formed the draw protection. The same pier is still in good condition on the same foundation.

The draw of the Clinton Bridge was the first iron draw of importance built in the West; it consisted of two spans of Bollman trusses hung by hog chains from a central tower; it was built by contract by the Detroit Bridge and Iron Works. This contract shaped the remainder of Mr. Pope's life. He resigned his position as Chief Engineer of the Galena and Chicago Union Railroad, associated himself with the Detroit Bridge and Iron Works, and was elected a Director of that company on February 9th, 1866. He opened an office in Chicago and remained there a year as the representative of the bridge works; he then went to Detroit and took direct charge of the engineering department. On May 7th, 1869, he was elected President of the company, and held this office until his death.

Mr. Pope's connection with this company, covering a period of

nearly 30 years, so completely identified the man and the corporation that no life of Mr. Pope is complete which does not include a history of the bridge works. The Detroit Bridge and Iron Works was incorporated in the year 1863, and succeeded to the business of the bridge-building firm of Charles Kellogg & Co., this firm consisting of Mr. Charles Kellogg, now deceased, and Mr. William C. Colburn, who is still treasurer of the company. As early as 1861 this firm had constructed iron bridges on the Illinois Central Railroad and on the Galena and Chicago Union Railroad; they were of the Bollman pattern, and may be considered the pioneer iron bridges built in the West.

From February, 1866, to the time of his death, with occasional short vacations, Mr. Pope gave the most thorough personal supervision to all the work constructed by this company. In 1866 the Detroit Bridge and Iron Works took the contract for the superstructures of the bridges at Burlington and at Quincy, these being the first two all-iron bridges built across the Mississippi River; they also contained the first draw bridges of what may be called modern dimensions, and Mr. Pope's ability as an engineer was strikingly illustrated in the special features of these draws; their turn-tables were far in advance of others built up to that time, and they were equipped with a system of lifting cams at the ends which are still as good as anything in use; both these bridges were opened for traffic in 1868.

In 1869 and 1870 the Detroit Bridge and Iron Works built the bridge across the Mississippi River at Hannibal, taking the entire contract for both substructure and superstructure, the first time this had been done on any great western bridge. Subsequently the same company took the contract for the bridge across the Missouri River at St. Joseph, which was opened in 1873, building the entire substructure and superstructure. Col. Eddy D. Mason, M. Am. Soc. C. E., was the chief engineer of both of these bridges, and they are both monuments of the skill of the engineer proper and the engineering contractor. Although no complete bridges of equal magnitude were subsequently built by the Detroit Bridge and Iron Works, the company has continued steadily in the bridge business, confining itself principally to superstructure. Its shops at Detroit have always ranked among the best class of bridge shops, and engineers have always felt that Mr. Pope intended to furnish the best work his shops could produce.

Among the last important works constructed by this company may be mentioned the Ferris Wheel for the World's Columbian Exposition and the steel gates for the new lock on the St. Mary's Falls Canal.

Socially Mr. Pope was one of the most delightful of men. Always chary about asserting himself, he had to be drawn out; but the drawing process disclosed his possession of a fund of the quaintest

humor, which became on occasions exceedingly bright and sparkling. He was especially happy in a certain affectation of cynicism which was oddly at variance with his real habit of thought, and used it very effectively in the puncturing of shams, which was somewhat of a passion with him. He was always, however, tenderly careful of the feelings of others, and resented with all the force of his really strong nature the reckless habit into which so many have fallen in recent years of trifling in speech and otherwise with the reputation of others. He was not given as a rule to impassioned utterance; but those who knew him best will recall more than one occasion when he indulged in it in denunciation of criticisms upon individuals which he deemed unwarranted, inexcusable and slanderous.

Mr. Pope loved the quiet of his home and the companionship of those dearest to him. In that circle he was both loved for his earnest affectionate guidance as husband and father, and respected and looked up to for his wisdom, his learning, his keen sense of justice, and his generous appreciation of all with whom he was closely associated. In the life of his own home the brightest and sweetest parts of his character were apparent. His life was entirely free from those unfortunate deficiencies of character and want of self control that often wear out the cheer and affection which are the necessary conditions of all true home life. His presence brought protection and happiness to his family and filled his home with cheerfulness and light.

He loved and was well acquainted with the best English literature, and this, with an unusual memory and facility of quotation, made him a most agreeable and instructive companion. During his residence in Detroit he was much sought after as a bright and witty speaker at public dinners.

Mr. Pope was married three times : In 1856 to Miss Harriet L. Bissell, daughter of Dr. Emory Bissell of Norwalk, Conn.; she died in the following year. In 1861 he married Miss Julia Bissell, a sister of his first wife; she died in 1872. In 1882 he married Mrs. Martha E. Patterson, widow of Philo M. Patterson of Detroit and daughter of W. B. A. Bissell, Bishop of Vermont, who survives him. He leaves three daughters and one son, all of whom, with his widow, reside in Detroit. His son, Willard Pope, has followed his father's profession, and is now an engineer with the Detroit Bridge and Iron Works.

Mr. Pope became a member of the American Society of Civil Engineers August 7th, 1872; he was elected a Director in January, 1893, and had nearly completed his term of office at the time of his death.

JAMES CLARENCE POST, M. Am. Soc. C. E.*
Major, Corps of Engineers, U. S. Army.

DIED JANUARY 6TH, 1896.

James Clarence Post was born at Newburgh, N. Y., July 30th, 1844. In 1861 he entered the Military Academy at West Point, and on graduating four years later was appointed Second Lieutenant in the Artillery. He was soon promoted to First Lieutenant and transferred to the Corps of Engineers, with which he was afterward connected until his death. After acting for a short time as Assistant Engineer in the improvement of government works in New England, he was appointed Assistant Professor of Mathematics at the Military Academy at West Point, where he remained for four years. The next three years were spent with the engineer battalion at Willet's Point, N. Y. From June, 1874, to November, 1882, he was Assistant Engineer under Lieutenant-Colonel Gillmore, and in temporary charge of his works to April, 1883. The next four years were spent in charge of river improvements in several states.

In May, 1887, Major Post was transferred to Washington as assistant to the Chief of Engineers, and in July, 1889, he became Military Attaché to the United States Legation at London. In July, 1891, he was a delegate to the Geographical Congress at Berne, Switzerland, and in 1893 attended the International Maritime Congress held in London.

From February, 1894, to December, 1895, Major Post was in charge of important works in the Northwest. The large jetty at the mouth of the Columbia River was completed under his supervision, and his work in 1894, during a great flood in that river, when the Cascades Canal was in danger of serious injury, was highly commended by an examining board composed of General William P. Craighill, Past-President Am. Soc. C. E.; Colonel George H. Mendell, M. Am. Soc. C. E., and Major Marshall. During this time he was also in charge of the construction and equipment of a boat railway from the foot of the Dallas Rapids to the head of Celilo Falls, and of many river and harbor works. In addition to these duties he was engineer of the Thirteenth Lighthouse District, served as a member of boards on bridge construction and river and harbor improvements, and was in supervisory charge of the construction of bridges across various streams.

In December, 1896, he was relieved from duty at Portland and detailed as the successor of the late Orlando M. Poe, M. Am. Soc. C. E., at Detroit, and was about to assume his new duties, when he died.

Major Post was promoted to Captain in October, 1871, and to Major in September, 1886. He was married at London in 1892, and leaves a widow and infant son.

He became a Member of the American Society of Civil Engineers on February 6th, 1878.

* Memoir prepared in the office of the American Society of Civil Engineers.

HENRY FREDERICK RUDLOFF, M. Am. Soc. C. E.*

DIED JUNE 1ST, 1895.

Henry Frederick Rudloff died at Caracas, Venezuela, June 1st, 1895. At the time of his death he was Chief Engineer of the Puerto Cabello and Araure Railway, and was also in the service of the Venezuelan government in charge of various minor engineering works.

He was born in Prussia, September 12th, 1846; graduated from the Gewerbe Institute in Berlin in 1866, and from that time until 1878 was engaged upon various public works in different parts of Europe, his father being a prominent constructor. He came to America in 1878, and during the next three years had several engineering engagements, among them office duties with Clarke, Reeves & Company, of Phoenixville, Pa.; with Gen. McClellan on a projected underground railway, and with the West Shore Railroad. In 1881 he entered the service of the government of Venezuela, and became Division Engineer on the La Guayra and Caracas Railroad, then in progress of construction, having charge of tunnels and bridges upon that road. In 1883 he was appointed Government Engineer at Caracas and designed a number of works, including a notable stone arch and an iron viaduct in Caracas. In 1884 he became the engineer of an American company, and under his direction the works of improvement of the harbor at Puerto Cabello were carried out. He was also the engineer of the Caracas and Antimano Railroad, and continued to the time of his death in government service, in addition to his engagement with the American company.

Mr. Rudloff was a man of exceptional ability in the direction of public works in Spanish-American countries. He had command of several languages, and was able to apply the results of varied experience to the special requirements of construction in those countries. He was entrusted, both by the Venezuelan government and by the representatives of foreign capital in that country, with the design and construction of engineering work of considerable magnitude, and always with satisfactory results. His death was sudden and unexpected, coming at a time of promise of much more extended possibilities. He leaves a widow and one son, who reside at Caracas, Venezuela.

He was elected a Member of the American Society of Civil Engineers January 6th, 1886.

* Memoir prepared by John Bogart, M. Am. Soc. C. E.

ISAAC MUNROE ST. JOHN, M. Am. Soc. C. E.*

DIED APRIL 7TH, 1880.

General Isaac Munroe St. John, eldest child of Isaac R. and Abby R. (Munroe) St. John, was born November 19th, 1827, at Augusta, Ga., where his father was then engaged in business. He graduated from Yale College with the degree of B. A. in the class of 1845, and received his degree of M. A. from that college in 1848.

On graduating he began the study of law in New York, but removed to Baltimore in 1847, where he was employed as Assistant Editor of the *Patriot*. He subsequently chose civil engineering as a profession, and was connected with the engineering corps of the Baltimore and Ohio Railroad until 1855. In that year he removed to Georgia, and was in charge of divisions of the Blue Ridge Railroad for five years.

In February, 1861, he entered the Confederate service as a private in the Fort Hill Guards of the South Carolina State troops. Two months later he was transferred to engineer duty, and rose rapidly to the position of Chief Engineer of the Army of the Peninsula. In May, 1862, he was made Major and Chief of the Mining and Nitre Bureau Corps. He was promoted through the various grades to the rank of Brigadier-General, and in 1865 to the position of Commissary General of the Confederacy.

After the war he resumed his profession, and from 1866 to 1869 was Chief Engineer of the Louisville, Cincinnati and Lexington Railroad. In 1870 and 1871 he was City Engineer of Louisville, Ky. From 1871 until his death he was Consulting Engineer of the Chesapeake and Ohio Railroad.

He was elected a member of the American Society of Civil Engineers on July 14th, 1871.

During the war he married a daughter of Colonel J. L. Carrington, of Richmond, Va. He died suddenly at his residence at White Sulphur Springs, W. Va., April 7th, 1880, aged fifty-two years.

* Memoir prepared by Edwin A. Hill, M. Am. Soc. C. E.

HOWARD SCHUYLER, M. Am. Soc. C. E. *

DIED DECEMBER 3D, 1883.

Howard Schuyler was born at Ithaca, N. Y., December 11th, 1844. He received a thorough academic education at the Ithaca Academy, and at the age of fourteen was preparing to enter college when the family removed to Kansas in the spring of 1859. His studies were interrupted by this removal to the frontier, although his faculty for intense concentration enabled him to cover a wide range of scientific reading under adverse circumstances, and he absorbed knowledge with unquenchable thirst and avidity. Two years of severe physical toil and hardship preceded the outbreak of the War of the Rebellion, and in May, 1861, he enlisted as a private soldier in the 2d Kansas Regiment. He was then little more than sixteen years old, but so mature of mind and physique that he easily passed muster as a man of legal age. Under General Lyon he was in the battles of Forsyth, Dug Springs and Wilson's Creek, after which his regiment, having served the six months of its enlistment, was disbanded, and he re-enlisted in the 11th Kansas Infantry, which was attached to the army of General Blunt, then in Arkansas, and participated in the battle of Cane Hill in November, 1862, and of Prairie Grove the month after. In January, 1863, he was commissioned First Lieutenant for bravery in the field, but declined the commission because of his youth and inexperience, and in the June following he was appointed Lieutenant of Artillery for conspicuous bravery, which he also declined. Three months later he accepted the position of Captain in the 11th United States Colored Troops, and, after bringing his company to a high degree of discipline, he was transferred to 4th Arkansas Cavalry as First Lieutenant, and afterwards was promoted to the rank of Captain, which he held until the close of the war. He was then offered a commission in the regular army, but declined to accept it, preferring to practice the profession which he always had in view, and for which he had been fitting himself. In all of his army service he passed through numerous pitched battles, where the fighting was almost hand to hand, but escaped without a scratch, although his clothes were riddled by bullets.

Shortly after leaving the army he entered the service of the Kansas Pacific Railway as rodman, while the road was being constructed between Lawrence and Topeka, Kan. He won promotion rapidly, and successively became leveler, transitman, and Locating Engineer in charge of a party. In 1867 he was put in charge of one of five parties

* Memoir prepared by James D. Schuyler, M. Am. Soc. C. E.

selected to survey the route of the thirty-fifth parallel road across the continent, under General William J. Palmer, and carried his line through to the Pacific Coast, completing the survey in the spring of 1869. It was an expedition requiring nerve, bravery and physical endurance in every member of the party, as they were harassed on all sides by Indians, and were subject to the hardships of thirst and starvation. On the completion of this survey he resumed charge the location of the main line of the Kansas Pacific, from Fort Wallace to Denver, about 200 miles, and completed its construction to that city in 1870. It was during this construction that he suffered the remarkable experience of having a locomotive pass over his foot, crushing all the bones of the toes, and yet recovered the complete use of the member. After his recovery he was promoted to Assistant Manager and Paymaster, which position he filled until the completion of the road to Denver.

During all these years of work on the location and construction of the Kansas Pacific Railway, the surveying parties were continually harassed by hostile Indians, and were frequently obliged to fight for their lives. His army life and acquaintance with warfare was admirable preparation for this experience, and on one memorable occasion, June 19th, 1869, Mr. Schuyler, while leading the advance of a preliminary survey near Sheridan, Kan., and while engaged in picking out a line for the party a few miles in the rear, was surprised and surrounded by a band of 100 or more hostile Cheyennes, but by coolness and presence of mind, he cut his way through the lines and escaped without a scratch, killing four Indians in the engagement. Five bullets were lodged in his horse; his field-glasses and one spur were cut off by bullets, and his clothes were well riddled; even the handle of his carbine was pierced and nearly torn from his grasp by a rifle ball. His plucky defence of himself saved the lives of the rest of the party, and they all succeeded in retreating to the military post fifteen miles distant, fighting their way through the swarming hordes of savages, whose well-laid plan for picking off the party one at a time was baffled by the coolness of their intrepid leader. The only member of the party wounded in this thrilling adventure was the writer.

In 1871 he became one of three organizers of the Denver and Rio Grande Railway, and was appointed its Secretary and Treasurer. In its service he visited Europe with General Palmer to examine the narrow-gauge railways of Wales and to interest foreign capitalists in its construction, in which they were highly successful. He afterwards filled the position of Chief Engineer and Assistant General Manager until May, 1873, when he resigned to accept the position of Chief Engineer of the North Pacific Coast Railroad, in California, and constructed the road from Sausalito, opposite San Francisco, to the Russian River, its northern terminus for many years subsequently.

In June, 1880, Mr. Schuyler was appointed Chief Engineer of the Mexican Central Railway, with headquarters at the city of Mexico, and located and constructed the road as far as the city of Leon. The strain which this work imposed upon his physical resources can only be appreciated by those who have undertaken the task of railroad construction in a foreign country, dependent upon a class of labor the most ignorant, inert and impassive on earth, with no conception of energetic completion of a task undertaken, but with innumerable feast days to be celebrated, during which all work must be suspended. Overwork and exposure in a malarious climate undermined his health and obliged him to retire and take a trip abroad in the spring of 1883. He was accompanied by his family and visited various health resorts and consulted eminent specialists, but finally succumbed to a complication of diseases at Davos, Switzerland, December 3d, 1883, leaving a wife and one son, the latter born in the city of Mexico.

Mr. Schuyler was a man distinguished among all who knew him as one of rare personal charm and magnetism, making hosts of friends wherever he went or with whomsoever he was thrown in contact. This enviable gift, combined with a natural faculty he possessed as a leader of men, and executive ability and capacity for systematic organization of an unusual order, constituted the secret of his success and gave promise for a brilliant future could he have rounded out the full measure of life. A keen sense of honor and dignity influenced all his actions and compelled his recognition as a gentleman in every sense that word implies.

THOMAS JENNINGS SEELY, M. Am. Soc. C. E.*

DIED OCTOBER 2D, 1883.

Thomas Jennings Seely was born at Chester, Orange County, N. Y., August 16th, 1848. He was graduated from the University of Michigan in June, 1869, in both civil and mining engineering, and in a few months began active work in the engineering corps of the La Clede and Fort Scott Railroad Company. In 1871-72 he filled an engineering position on the Decatur and State Line Railroad, and in 1876 was Chief Engineer of the Chicago and Millington Railroad.

In April, 1878, Mr. Seely was appointed a transitman in the engineering corps of the Atchison, Topeka and Santa Fé Railroad Company, engaged in surveys in New Mexico under Lewis Kingman, M.

* Memoir prepared from information furnished by A. A. Robinson, M. Am. Soc. C. E.

Am. Soc. C. E. In the fall of 1878 he was made Engineer of Track-Laying on the New Mexico and Southern Pacific Railroad Company, and served in that capacity until 1879, when he was ordered to Kansas to take charge, as Superintendent of Construction, of certain new lateral lines, which the rapid advance in the settlement of the State rendered necessary.

Under his direction and within a trifle over two years from the date of his appointment as Superintendent of Construction, the following lines were built and put in operation: Howard to Eureka, 29.2 miles; Wichita to Caldwell and Arkansas City, 91.9 miles; Burlingame to Manhattan, 56.6 miles; Florence to Ellinwood, by way of McPherson, 98.6 miles; Eldorado to Douglas, 24.3 miles; a total of 300.6 miles.

From the completion of the line from Burlingame to Manhattan until November 1st, 1880, Mr. Seely served as Superintendent in charge. On that date he was relieved of this duty and appointed Superintendent of Water Service of the main line and branches, his jurisdiction extending as far west as Pueblo and Las Vegas. These responsible duties he performed in addition to those of Superintendent of Construction until May 18th, 1881, when the water service was consolidated with the Bridge and Building Department.

In September, 1881, he was made Division Superintendent of the Las Vegas Division, extending from Raton to Wallace, a distance of 206.1 miles, and was also made Assistant Engineer, with direct charge of track, bridges, buildings and water service on his division.

In July, 1882, owing to ill health, Mr. Seely was obliged to resign these positions, and until October of the same year he sought by rest to regain his strength. On October 27th, 1882, he was made General Superintendent of the Sonora Railway, extending from a connection with the New Mexico and Arizona Railroad southward through Sonora to Guaymas, on the Gulf of California. On November 15th of the same year he was advanced to the position of Assistant General Manager of that line. By September, 1883, he was so weakened by consumption that he was forced to resign his position and leave Guaymas. He started for his old home at Oswego, Kendall County, Ill., but on October 2d, 1883, he died in his car just before the train reached Atchison. With him at the time were his wife and two doctors of the railway company's staff.

Mr. Seely was married in September, 1873, to Anzoletta E. Teller, of Oswego, who, with two sons, survived him. He was elected a Member of the American Society of Civil Engineers on February 1st, 1882.

He was never a strong man physically, but he possessed great powers of endurance, was devoted to his profession, and achieved much success in it, as shown by the preceding record.

SAMUEL HENRY SHREVE, M. Am. Soc. C. E.*

DIED NOVEMBER 27TH, 1884.

Samuel Henry Shreve was born at Trenton, N. J., August 2d, 1829, his ancestors being among the colonial proprietors of New Jersey. He graduated from Princeton in 1848, and from the Harvard Law School two years later. He practiced law at Green Bay, Wis., and subsequently at Chicago until about 1853, when he returned East to prepare himself for the engineering profession, toward which he was attracted by a love of mathematics. His best work was done as an engineer and his reputation achieved as such.

He was engaged early in his career as an engineer in defining the complicated boundary lines under old colonial deeds in Ocean County, N. J., and made careful surveys for the purpose. Between 1860 and 1863 he was engaged as Engineer on the Southern Railroad of New Jersey and its branches, and was connected later with other surface railways. He was interested in the elevated railway projects in New York City from their inception in 1866, but took no active part until he aided the development of the Gilbert Elevated Railway just before it became the Metropolitan Elevated Railroad. He was retained as Consulting Engineer by one of the first rapid transit commissions in New York, and afterward by the Metropolitan Elevated Railroad. He became identified with the design and construction of the Sixth Avenue line and the structures on the east and west side of the city, built for the joint use of the New York and the Metropolitan Elevated railways. At this time, the most active in elevated railway construction, Mr. Shreve was recognized as a leader in this class of engineering work, and in 1881 was appointed Chief Engineer of the Brooklyn Elevated Railroad, a position he held to the time of his death, November 27th, 1884. All the essential features of the first Brooklyn elevated road were designed by him, and the most important portion of the line had been completed before he died.

In 1873 he published a work on the strength of bridges and roofs, which was translated into French. It was one of the first to succeed the pioneer work of Squire Whipple, printed in 1847, and discussed only the simple forms of trusses. It was to have been followed by another volume on the cantilever and the more complicated trusses, which was partly written at the time of his death.

The mathematical attainments of Mr. Shreve were notable, but in his published writings he has made use of only algebraic processes. In order to avoid the use of the calculus in problems where the maximum or minimum values of a function have to be determined,

* Memoir prepared from papers on file at the House of the Society.

the equation containing only the first and second powers of the independent variable, he devised a process which he explained in an article in *Van Nostrand's Engineering Magazine*, Vol. XV, page 530. While recognizing the utility and convenience of graphics, he preferred algebraic methods of computation, in which he became so expert, that, having written an equation of the second degree, he effected the transformations mentally, and wrote down the values of the variable after a brief pause. He served as Associate Editor of the 1878 edition of "Johnson's Encyclopedia."

Mr. Shreve became a Member of the American Society of Civil Engineers, May 19th, 1869. In Volumes III and IV of *Transactions* will be found two discussions of some length written by him on the subject of arch trusses.

FREDERICK ELLSWORTH SICKELS, M. Am. Soc. C. E.*

DIED MARCH 9TH, 1895.

Frederick Ellsworth Sickels, famous as the inventor of the Sickels cut-off, a device by means of which the plans of James Watt for utilizing the economic advantages of expanding steam became for the first time thoroughly and practically applicable, and of many other no less ingenious if not equally important inventions, died of heart failure at Kansas City, Mo., at the age of 76 years, on March 9th, 1895. The modern factory, stationary, steam engine is substantially the work, in its evolution from the old Newcomen engine of 190 years ago, of three men: James Watt, who converted the machine of which Newcomen was the real inventor, from its primitive and enormously wasteful form into a comparatively efficient apparatus by securing reduction of internal wastes from about 95% to perhaps 30 or 40% by the adoption of a condenser separate from the working cylinder and by the use of a steam jacket, while improving at the same time its thermodynamic action, to such extent as the devices available at the time permitted, by the employment of a cut-off arrangement acting on a crude system of valve gearing; Frederick Sickels, who produced the first practicable drop cut-off gearing for the rotatory engine; and George Corliss, who devised a refined and specially contrived type of engine peculiarly adapted to the successful utilization of the ideas of Watt and of Sickels, and the highest refinement of steam-engine construction of the time. Watt was unable to avail himself fully of the advantages of his own plan of

* Memoir prepared by Robert H. Thurston, M. Am. Soc. C. E.

expansion of steam by closure of the induction valve at an early point in the stroke of the piston, in consequence of two facts. Steam pressure was always too low in his engines to permit any considerable expansion, and even were the pressures higher, the rudeness of his devices and the ineffectiveness of his provisions for insuring steady rotation of the engine shaft precluded the employment of now familiar methods of expanding steam behind the piston. Sickels provided a system of construction and operation which permitted the detachment of the valve from its moving mechanism, and allowed it to drop back into its seat, thus almost instantly effecting closure at any desired point; while the use of a dash-pot containing water, oil, or air checked its fall as it approached its seat closely, and thus evaded the danger and annoyance consequent upon its unrestricted impact. Corliss perfected the engine later by adopting reduced clearances, partially balanced sliding valves moving with accelerated or retarded velocities close to the cylinder; a steam and an exhaust valve at each end, opening quickly and widely, detached automatically, as previously practiced by Sickels, dropping quickly, closing instantly, and moving comparatively little while closed. The invention of Sickels was an essential element of success in the steam-engine of the nineteenth century, and the name of Frederick Ellsworth Sickels rightfully stands beside that of James Watt, both as an inventor and as a builder, for he built numerous engines, stationary and marine, and gave a half-century of busy life to the work.

Sickels was a mechanic and an inventor by nature and inspiration. He was born in 1819 at or near Camden, N. J., received a common school education, and was then employed as rodman, at the age of 17, on the Harlem Railway, but promptly accepted the opportunity then offered him of an apprenticeship under the famous mechanic and engine-builder, James P. Allaire of New York. His father, John Sickels, who was an alumnus of Columbia College, later a physician and at one time Health Officer of New York, is said to have disapproved of his choice of a vocation, but the genius of the youth determined his future, and he completed his apprenticeship at the Allaire Works, and his became, as has been said by one of his biographers, "the only one of all the great names since James Watt to add a radically new and important elemental idea to the theory of steam-valve action, and to couple his new thought with mechanical details of such apt suitability as to bring it easily into the range of common practice,"* and this was before he had maintained his majority. The prime necessity for successfully putting into operation the idea of Watt and of producing a good expansion gear was ability to open wide the steam port, and to close it at the right moment in such manner as to cut off the steam supply instantly, giving a square corner on

* O. T. Porter.

the indicator diagram and converting energy thermodynamically by as nearly adiabatic expansion as possible throughout the remainder of the piston stroke. This the Sickels drop cut-off accomplished actually and satisfactorily.

The invention of Sickels, for the first time in the history of the steam engine and in actual every-day practice, produced a distribution of steam approximating and closely coinciding with the ideal described by Watt in his patent of 1782, giving an indicator diagram with a sharp cut-off corner. This is one of the essential factors of maximum economy of operation of the engine. Its introduction immediately effected great improvement in current practice, and designing and constructing engineers have never ceased from that time to adhere to the principles and methods then first illustrated fully in application. Watt had proposed the expansion of steam by early cut-off, but he found, on attempting its introduction, what were insuperable difficulties in his time, in the irregular action of the engine, the impossibility of effecting prompt cut-off with his mechanisms, and the ignorance and obstinacy of the enginemen of the day, and practically gave up the task. He had adopted a ratio of expansion of two as being practicable, and advised four as the probably desirable figure. All his plans came to naught, however, in this field. Sickels overcame every difficulty by his ingenuity, enthusiasm and persistence, and led the way to the standard current practice of our time. His first patents were issued in 1841.

Immediately upon the public announcement of the new device, its introduction began. The firm of Thurston, Green & Company, then already well established and well known for its success in the construction of both stationary and marine engines of the then largest class, purchased the land rights, and Sickels himself, reserving the marine rights, went energetically about the introduction of the invention into the steam merchant and naval fleets. Thurston, Green & Company made the Sickels valve motion their exclusive form of steam valve gearing for mill engines, at once put the new engine on the market, and built many machines of all sizes and classes. Sickels was less prompt in securing a place for his invention on board ship, but he built it into the engine of the *Champion*, one of Vanderbilt's steamboats on Long Island Sound, and later applied it to many steamers on that Sound and on the Hudson River, commencing with the *North America*. The United States Navy, under the supervision of Engineer-in-Chief Haswell, adopted the cut-off, and it was employed on the *Waterwitch* in 1847, on the *Powhatan* in 1848, and subsequently on other vessels. It proved perfectly satisfactory on the side-wheel ships of that time, as on all slowly moving engines. On shore the invention found immediate and extensive application and was only driven out, about 1860, by the Corliss engine, patented in 1849, by

George H. Corliss, in which the same result was accomplished by devices differing in form from those of Sickels, but always claimed by the latter and by many other engineers to be infringements upon his patents. This claim was passed upon by the Supreme Court of the United States after prolonged litigation, and the decision was rendered in favor of the defendant. No one questions, nevertheless, the claim of Sickels to the distinction of having originally and successfully led the way in the construction of a practicable and successful form of detachable valve gear, a drop cut-off.

Sickels made many other inventions, less well known simply because the greater light of the more important invention obscured that of the lesser ones. He never received full, or even moderate, compensation for the cut-off, or for any other of his characteristically ingenious and valuable devices. Perhaps the most remarkable of these minor devices, both in the eye of the inventor and in the estimation of others, was his steam-steering gear, an arrangement of small steam engines coupled to an ordinary steering gear by means of which a touch of the finger could be made to control the most powerful and speediest ship when in full career. This invention was first recognized publicly when exhibited at the London International Exhibition of 1862. Very powerful steamships were by that time afloat, and often required several men, sometimes eight or ten, at the helm, to steer the vessel readily and safely. The Sickels steam steering gear enabled one man to direct the course of the largest and fastest ship with as little difficulty as the smallest rowboat. A child might, with this device, put the helm of the *Campania* hard over when at full speed at sea. The arrangement consisted of a pair of small engines driving the barrel of the steering apparatus, as ordinarily attached to the steering wheel, and so placed that a small steering wheel, attached in such manner as to move the reversing mechanism of the engine, should make the same movements, in so doing, as would the large hand steering wheel. The helmsman operated this little wheel precisely as he was accustomed to handle the wheel of the old gear, and it required no greater effort than was needed to move the steam valve. All large vessels are now thus steered. By an ingenious device, the engines were made to move the helm over to the position desired by the wheelman, and to stop there automatically, following the hand of the steersman with absolutely perfect docility and precision.

Sickels patented altogether about thirty devices, many being improvements in detail upon his principal inventions. He lived and died, however, a "poor inventor," spending the comparatively small returns from his invaluable work, as fast as received, in the prosecution of experiments and in bringing out new devices. He deserved honors second only to those accorded James Watt and he met the fate of the

prophet of the proverb who had honor except in his own country; but Sickels was little honored, even abroad. He lived and died almost unknown outside his profession, and so modest, retiring, and disinclined to urge his claims, that he was not extensively acquainted in his own guild. He spent his life mainly in the development and introduction of his inventions, assisted in legal matters by one of the ablest patent lawyers of the time, Mr. Edwin N. Dickinson, and in designing by a brother, Theophilus Sickels, M. Am. Soc. C. E., a well-known member of the engineering profession. After the expiration of the more important Sickels' patents, the brothers worked together in the construction of the Omaha Bridge across the Missouri River, and, later, the great inventor became the Chief Engineer of the Kansas City Water Works, which position he held at the time of his death.

Mr. Sickels' struggles to maintain his rights against infringers of his patents were among the most interesting events of the history of inventions. The suits against Corliss, particularly, brought into court the most famous legal and engineering talent of the time, and Curtis, Seward, Keller and Dickinson, as counsel, the Renwick brothers, Copeland, Hill, Greene, as experts, and the Thurstons, Benjamin F., famous later as the leading patent attorney and pleader of his generation, and Robert L., the founder of the first Providence Steam-Engine Company of 1837 and of the engine-building firms of Thurston, Gardner & Company and Thurston, Greene & Company, gave the controversy added interest by their presence on either side, by their able arguments and their learning, and by their knowledge of contemporary and earlier inventions. These cases were carried up to the Supreme Court, where after a series of victories in the Circuit Courts, Sickels was finally defeated. Corliss had, as adjudged by the court of last resort, for the first time combined the use of an expansion gear, original in idea with Watt, with a trip cut-off, original in principle with either Watt or some other inventor prior to Sickels, and with the attachment of the governor to determine the point of cut-off, original with Corliss himself in form, but in principle of earlier date, patented by Zachariah Allen, of Providence, as early as 1837, and used abroad in the form of the French cam before Corliss. Sickels was adjudged entitled to an exclusive right to his own particular form of trip and of dash-pot, and Corliss to his own particular group of details and method of governing; and the latter was declared not to infringe on the former. Many professionals were led to criticise this decision strongly, but it was subject to no appeal and ended the litigation.

Personally, Mr. Sickels was one of the most attractive and lovable of men. The writer came to know him in the early days of his patent litigations and retained an acquaintance with him throughout the remaining forty years of his life, and was always impressed by his kindness, his patience, his good temper and his perfect integrity. He was

careless in dress and in his habits of business, and curiously absent-minded; but he always adhered steadily to his plans, in spite of all discouragements, and found the way to his end with invariable certainty. He was a man of broad interests and extensive general information, and heartily loyal to his friends, absent or present. He was honest and true from first to last. He was never discouraged, and to the very end held fast to his faith in the ultimate success of his inventions, though without either credit or financial reward adequate to his work. And even when the award of the International Jury of the Centennial Exhibition, at Philadelphia, in 1876, made and signed by a jury composed of a group of the greatest men ever brought together on such an occasion, failed to see the light, he went about his work as placidly and cheerfully and determinedly as ever. The man was the equal of the inventor, the inventor had few equals in history, and few men have done more for the promotion of the development of civilization than did Frederick Ellsworth Sickels.

Mr. Sickels was elected a Member of the American Society of Civil Engineers on January 7th, 1891.

WILMON W. C. SITES, M. Am. Soc. C. E.*

DIED OCTOBER 1ST, 1885.

Wilmon W. C. Sites was born in 1849, and began his engineering career when he was nineteen years old as a rodman on the South Mountain Railroad. After spending about four months in this position, he entered the junior class of the Pennsylvania Polytechnic College, from which he was graduated in 1870.

From June, 1870, until February, 1871, he was rodman and assistant engineer on the construction of the Columbia and Port Deposit Railroad, a position he left to become Assistant Engineer of Surveys on the Stoney Creek branch of the North Pennsylvania Railroad. In a few months he resigned from this work and was appointed Assistant Engineer of the Berks County Railroad under Mr. J. Dutton Steele, and after the resignation of that gentleman, became Principal Assistant Engineer, a position he retained until the completion of the road in 1875.

In 1876 Mr. Sites removed to Jersey City, and commenced practice in general city engineering and surveying work, becoming Township Surveyor for West Hoboken and the Town of Union, in Hudson County, New Jersey, and superintending the construction of a number of public improvements in these places.

In 1877 he was appointed by Levi W. Post, M. Am. Soc. C. E., then Chief Engineer of the Jersey City Public Works Department, Surveyor

* Memoir prepared by E. W. Harrissou, M. Am. Soc. C. E.

in that department, having special charge of preparing a map of the water pipe systems of the city, proper knowledge of which was in a very confused state, the pipes having been laid at different periods by different municipal bodies, which in 1870 were united to form the present city, and no record having been preserved.

In 1879 a change of political control resulted in the appointment of a new chief engineer, and Mr. Sites returned to private practice.

In 1881 he was appointed Chief Engineer of the Public Works Department, and held the office until the spring of 1884. During this time he completed the second high-service distributing reservoir on Jersey City Heights, which had been commenced in 1871. Bringing this reservoir into use enabled him to draw down and clean the old reservoir, which had been in constant use for thirty years. He also laid the main supplying Bayonne City with water from the Jersey City works.

During Mr. Sites' term of office the deterioration of the water of the Passaic River at Belleville became a serious menace to the prosperity of Jersey City and Newark. The two cities combined in efforts to prevent the growth of the evil, and made an unsuccessful attempt to secure legislation to that end. Mr. Sites, as Chief Engineer of the Jersey City Department, took a very active part in the necessary investigations and preparations of evidence to sustain the cities' side of the agitation.

In 1884, on a change of administration, Mr. Sites resigned his office and entered into partnership with Edlow W. Harrison, M. Am. Soc. C. E., as engineers and surveyors.

The Legislature of 1884 had passed an act entirely revolutionizing the system of taxation of railroad and canal property in the State. The enforcement of the act was combated by all of the great transportation companies having interests in New Jersey. By the provisions of the act, which is now the settled system of taxation for this class of property in the State, the roads were required to be valued for assessment at their true value, and one of the elements of value was determined to be the cost of reproduction, less deterioration.

The new firm was selected by the State Board of Assessors, the body charged with the execution of this law, to act as the engineers for the State in the valuation of the railroad properties. In this work Mr. Sites was engaged until his death. The labor entailed was incessant. Not only was the field work of measurement of quantities and fixing market values of all the innumerable details which go to make up a railroad plant, and called for the supervision of a large corps of assistants, to be carried forward, but at the same time the attacks in the courts made by the companies upon the values as fixed and determined had to be met and answered. The examinations and cross-examinations of the members of the firm occupied many days. For over a year the work required fifteen or more hours out of the twenty-four.

Mr. Sites was never a healthy man, and, while Chief Engineer of

the city, had shown symptoms of consumption. His perseverance was remarkable, and toward the end of his labor, he spent many days at active work, when another man would have been in bed.

Mr. Sites did not live to see the full completion of the work he had been engaged upon, and the establishment of its correctness by the highest courts of the State. Of him it may be truly said, "he died in harness," for within a week of his death, while lying upon the bed from which he never rose, he advised with his partner on the details of the engineering work of the cases then under consideration in the courts.

Mr. Sites was elected a Member of the American Society of Civil Engineers November 6th, 1878.

JOHN CHAMBERS THOMPSON, M. Am. Soc. C. E.*

DEED JANUARY 17TH, 1880.

John Chambers Thompson was the son of Jared and Jane Anthony, and was born in Philadelphia, Pa., February 5th, 1844. After the death of both parents, he was adopted by the Rev. Dr. Thompson, at that time preaching in Philadelphia, and his name was changed from Anthony to Thompson.

He was graduated from the Rensselaer Polytechnic Institute in the class of 1865, and was soon engaged as Assistant Superintendent of Construction of the Bessemer Steel Works of Messrs. Winslow, Griswold & Holley, of Troy, N. Y. He retained this position for two years, and then became Superintendent of the plant for about a year.

In 1868 he was appointed Assistant Engineer on the Croton Water-Works of New York City, and in 1870 held a similar position in the Department of Public Works of that city. In 1872 he again became Superintendent of the Bessemer Steel Works at Troy, and remained there for two years, when he went to the Crown Point Iron Company at Crown Point, N. Y., as Superintendent of its railroad department.

From 1877 to 1879 he was Assistant Engineer of the Croton Water-Works of New York City, and was subsequently connected for a short time with steel works at Cleveland, O.

His health then began to fail, and he went to Minnesota to recuperate. Consumption had attacked him, however, and he died of this disease on January 17th, 1880.

Mr. Thompson was a man very much beloved by those who knew him, of genial disposition and a thorough student. In the various positions held by him, he gave satisfaction to his employers, and his early death was a loss to the profession, in which, had his life been spared, he would no doubt have taken a prominent position.

He was elected a Member of the American Society of Civil Engineers on May 18th, 1870.

* Memoir prepared from a "Biographical Record of the Officers and Graduates of the Rensselaer Polytechnic Institute," by Professor H. B. Nason, and from information furnished by William H. Wiley, M. Am. Soc. C. E.

CHARLES TRUESDELL, M. Am. Soc. C. E.*

DIED APRIL 23D, 1894.

In the death of Charles Truesdell, at Germantown, Pa., on April 23d, 1894, the American Society of Civil Engineers and the profession lost an old and useful member. He was born in Camillus, N. Y., in 1833, and educated in the academies of Onondaga and Madison counties. The son of an engineer, he early manifested a taste for the profession, to which he devoted forty years of his life.

In 1851, at the age of eighteen, he began his professional career under the late John McNair, in locating a railroad from Fort Niagara to Chippewa, on the Canadian frontier, and in the construction of the railroad from Lewiston to Niagara Falls. He was next associated with Hon. George Geddis in the service of the State of New York in surveys for the removal of the bar in Seneca River at Jack's Reefs. In 1853, under the late Hon. Van R. Richmond, he entered the service of the State of New York in enlarging the Erie Canal, subsequently having charge of some of the most important works on the canals, among them the new channel for Canandaigua River outlet, extensive dredging of Seneca River, the high embankments across the Montezuma marshes, and the Seneca River aqueduct. He continued in the service of the State many years in various capacities, and was appointed by the Governor to superintend the development of the salt wells at Montezuma.

He was Chief Engineer of the Cayuga Marsh Improvement Company, Chief Engineer in charge of surveys and location for a railroad from Chittenango to Cazenovia, N. Y., and was inspector in charge of the extension of harbor works at Cleveland, O., under the late General T. J. Cram and Major Walter McFarland, of the Corps of Engineers, U. S. Army. This position he resigned in 1868 to accept the appointment of Division Engineer in charge of the Uintah Division of the Union Pacific Railroad in Utah, continuing in that position until the road was completed in the fall of 1869. As Resident Engineer under Chief Engineer D. H. Wood, he had charge of the location and construction of the Montclair Railroad, now known as the Greenwood Lake Railroad, from Jersey City to Greenwood Lake, covering a period of about four years. At the expiration of this time he returned to the service of the State of New York, and was in charge of the construction of the State dam at the outlet of the Cazenovia Lake, of the completion of the Oneida Lake Canal, and of repairs to dams on Oswego River and Chenango Canal reservoirs and feeders. He was Chief Engineer for the

* Memoir prepared by Colonel George Truesdell, U. S. Army, and Major C. W. Raymond, M. Am. Soc. C. E.

Syracuse Water Company, and subsequently Resident Engineer in charge of location and construction of the Delaware Division of the New York, Susquehanna and Western Railroad in New Jersey and Pennsylvania.

In 1891 Mr. Truesdell was appointed Assistant Engineer upon the extensive improvement of the harbor of Philadelphia under Major C. W. Raymond, M. Am. Soc. C. E. In this very responsible position he continued until his death, and he won the confidence, affection and respect of all his associates. He had a keen sense of responsibility and was earnestly devoted to duty, even while suffering from his last illness. Industrious and persevering to a remarkable degree, he was never contented until he discovered what he thought was the best solution of any problem, and his judgment was seldom at fault. He had a high sense of honor, was unselfish, kind and affectionate in all his family relations, and faithful in every relation of life.

In 1869 he married Mary Bradford, youngest daughter of Colonel John M. Fessenden, of Boston, Mass. Two children survive him, John Fessenden and Harriet T., wife of Carl Hering, an electrical engineer. He was elected a Member of the American Society of Civil Engineers September 15th, 1869.

LOUIS ROBERTS WALTON, M. Am. Soc. C. E.*

DIED NOVEMBER 9TH, 1885.

Louis Roberts Walton was born in Chester County, Pennsylvania, November 24th, 1842. He graduated from the Polytechnic College of the State of Pennsylvania in the class of 1863, and soon afterwards entered the employ of the Philadelphia and Erie Railroad Company, being connected with the harbor improvements at Erie, Pa. He remained with this company for four years, and then became Resident Engineer on construction of the Baltimore and Potomac Railway Company. In 1872 he was again employed on the Philadelphia and Erie Railroad, this time as Resident Engineer on construction, and the following year he went to the Pittsburg, St. Louis and Chicago Railroad Company as Principal Assistant Engineer.

In 1881 he accepted the position of Engineer of the St. Bernard Coal Company, of Earlington, Ky., the largest corporation of the kind in the State, and a pioneer in the introduction of improved mining machinery. He remained with this corporation until his death on November 9th, 1885. As an engineer he was careful, accurate and

* Memoir prepared by John B. Atkinson, M. Am. Soc. C. E.

energetic. Coal-cutting machinery was just introduced into the mines at the time he became connected with the St. Bernard Company, and much of the success accomplished by the machines is due to his efforts. As a man and a citizen none stood higher. In his death the Society lost a most honorable member.

Mr. Walton was elected a Member of the American Society of Civil Engineers on April 1st, 1885.

ORLANDO BELINA WHEELER, M. Am. Soc. C. E.*

DIED JUNE 3D, 1896.

Orlando Belina Wheeler was born at Lodi, Mich., November 29th, 1835. He graduated from the University of Michigan in 1862, and then became acting assistant under Dr. F. Brünnow in the observatory of that institution. From 1863 to 1871 he was in charge of astronomical and geodetical triangulation parties on the United States Lake Survey, and from 1871 to 1878 was in charge of the computing division of the same survey. He made a specialty of astronomy, and while with the Lake Survey was sent as Assistant Astronomer by the United States Government to Siberia, to observe the transit of Venus in 1874, and to Colorado in 1878 on the total eclipse expedition of that year. In 1882 he was again sent by the Government as Assistant Astronomer with the expedition that went to Patagonia to observe the transit of Venus. Mr. Wheeler was the first to use the Morse alphabet in solar telegraphy, a method of communication he established while engaged in the triangulation of the Great Lakes.

After completing his astronomical work for the Government, he made a tour of the world, returning to this country in 1885 to become Principal Assistant Engineer in the office of the Missouri River Commission at St. Louis, Mo. This engagement continued until his death from apoplexy on June 3d, 1896, after an illness of but ten hours.

In social life Mr. Wheeler was gentle and unassuming, his quiet manner, quick intellect and learning making him beloved by all. He leaves a widow, one daughter and three sons.

Mr. Wheeler was elected a Member of the American Society of Civil Engineers on November 2d, 1887.

* Memoir prepared from information furnished by B. H. Colby, M. Am. Soc. C. E., and from papers on file at the House of the Society.

JOHN ALLSTON WILSON, M. Am. Soc. C. E.*

DIED JANUARY 19TH, 1896.

John Allston Wilson was born at Phoenixville, Chester County, Pa., April 24th, 1837. He was the eldest son of W. Hasell Wilson, Hon. M. Am. Soc. C. E., a native of Charleston, S. C., an eminent railroad engineer, and Jane Miller Wilson, both of whom are still living.

Mr. Wilson came of distinguished ancestry. He was the fifth in his generation to follow the profession of engineering. The name Allston was that of his great grandmother, who was the daughter of Capt. William Allston of Marion's brigade during the Revolutionary War, and a half-sister of Washington Allston, painter and poet. She was the wife of William Hasell Gibbes, a lineal descendant of Robert Gibbes, who was Chief Justice of South Carolina in 1708, and Governor in 1710-12.

John A. Wilson received his early education at private schools, and at the age of sixteen entered the Rensselaer Polytechnic Institute of Troy, N. Y., graduating with the degree of C. E. in July, 1856. In the early part of the year 1857 he was appointed topographer under Mr. John C. Trautwine on surveys in Central America for the Honduras Inter-oceanic Railway, on which work he continued until the return of the party to the United States in the summer of 1858. He then entered the service of the Pennsylvania Railroad Company as Assistant Engineer, and was engaged on work on the main line of that road. In 1860 he was promoted to the position of Principal Assistant Engineer, and until 1864 was engaged in the construction of railroad shops, bridges and branch railroads in the vicinity of Philadelphia. In addition to this, from 1861 to 1864 he was Chief Engineer of the Junction Railroad, connecting the Pennsylvania, the Philadelphia, Wilmington and Baltimore, and the Philadelphia and Reading Railroads, a piece of work involving varied and heavy construction. He also made the location for the Connecting Railway between the Pennsylvania Railroad and the Philadelphia and Trenton Railroad.

In 1863 Mr. Wilson served in the defence of his country as aide on the staff of General D. N. Couch, with the official rank of Captain. General Couch was then in command of the Department of the Susquehanna, and Captain Wilson had charge of the construction of fortifications in the vicinity of Harrisburg, Pa.

From 1864 until 1868 he occupied the position of Chief Engineer for the Pennsylvania Railroad Company, lessee of the Philadelphia and Erie Railroad, with headquarters at Williamsport, Pa.

* Memoir prepared by Jos. M. Wilson, M. Am. Soc. C. E.

From 1868 to 1870 he was Chief Engineer of Maintenance of Way on the main line of the Pennsylvania Railroad, with residence at Altoona. During the period from 1870 to 1875 he made the location and superintended the construction of the Low Grade-Division of the Allegheny Valley Railroad between Driftwood on the Philadelphia and Erie Railroad and Red Bank on the Allegheny River. At the same time he was also Chief Engineer of the Morrison's Cove Railroad, a branch of the main line of the Pennsylvania Railroad.

In January, 1876, the firm of Wilson Brothers & Company, Civil Engineers, Architects and Consulting Engineers, was organized, in which he was the senior member up to the time of his death. This firm has designed and had charge of the construction of many important structures, one of their recent great buildings being the Philadelphia and Reading Terminal Station at Philadelphia.*

One of the provisions of this firm allowed any member to hold an official position in his individual name, with the benefit of consultation and advice from the other members, all compensation being reported to and paid into the firm, and all such professional work being considered as part of its operations. Under this provision John A. Wilson acted personally in many important works as Chief or Consulting Engineer. Among these may be mentioned: Chief Engineer of the Bloomsburg and Sullivan Railroad, the North and West Branch Railroad, the Staten Island Rapid Transit Railroad, the Bellefonte and Buffalo Run Railroad, the Nittany Valley and Southwestern Railroad, the Columbia and Sullivan County Railroad, the Philadelphia Belt Line Railroad and the Philadelphia and Reading Terminal Railroad; Consulting Engineer of the Philadelphia and Reading Railroad for the Pennsylvania Avenue Subway, etc., etc.; also as Expert Engineer or witness for a large amount of railroad and similar public work, including many cases in litigation, such as railroad crossings, etc. Mr. Wilson displayed remarkable ability in matters connected with railroad law, making him extremely valuable as an expert adviser or witness in such cases. In some instances he worked up the whole plan of procedure for a case, and on an occasion not long before his death, when he rendered an opinion to a prominent lawyer, he was complimented by a letter from him, in which he said, "Your knowledge of the law on this subject warrant your being made an L.L.D."

In addition to his membership in this Society, dating from June 7th, 1876, Mr. Wilson was also a member of the American Institute of Mining Engineers, the Franklin Institute, the Historical Society of Pennsylvania, the Philadelphia Art Club and the St. Andrew's Society of Philadelphia. He was a vestryman and communicant of St. Andrew's Protestant Episcopal Church, West Philadelphia. He leaves a wife, four daughters and two sons.

* See *Transactions*, Vol. xxxiv, p. 115.

JAMES HUGH STANWOOD, Assoc. M. Am. Soc. C. E.*

DIED MAY 24TH, 1896.

James Hugh Stanwood, who became an Associate Member of this Society October 3d, 1894, was born July 17th, 1860, at Brunswick, Me. His earlier education was received in the public schools of Portland. In 1879 he entered the office of Edward C. Jordan, M. Am. Soc. C. E., at Portland, and for about a year and a half was engaged in general land surveying. He afterward served on the survey for a railroad between North Bridgeton and Saccarappa, Me., and as assistant in the office of the City Engineer of Portland, and in the spring of 1881 went into the employ of the Maine Central Railroad Company as leveler and transitman.

Although in 1883 he entered the Massachusetts Institute of Technology as a student, and continued there for four years, he was still engaged during his summer vacations upon engineering work on the Maine Central Railroad. Graduating in 1887, he went to the Philadelphia Bridge Works as assistant to the designing engineer, and somewhat more than a year later returned to the Institute of Technology as Assistant in the Department of Civil Engineering. He afterward became Instructor, and continued in active service at the Institute, in charge of the drawing-room work in bridge design, until within a few months of his death, being compelled finally to give way before the inroads of Bright's disease.

He was enthusiastic in his attachment to the profession of civil engineering, and was not infrequently a contributor to its periodicals. He collected many specimens illustrating the rusting of iron and steel in exposed structures, such as bridges, made a careful study of the matter, and in 1895 presented a discussion on the subject before this Society. He also devised simple formulas to accord with the experiments upon the strength of wooden posts, which appeared in the *Railroad Gazette* in 1892 and 1894 and have been well received by engineers.

Mr. Stanwood was characterized by great faithfulness to all the details of his duties, and by an abounding fund of good nature which, combined with a frank and generous spirit, won for him many friends and the enduring regard of all his students. He died May 24th, 1896, in his thirty-sixth year, leaving a widow and three children.

* Memoir prepared by Dwight Porter, M. Am. Soc. C. E.

CHARLES WOOD, Assoc. M. Am. Soc. C. E.*

DIED NOVEMBER 28TH, 1895.

Charles Wood was born in Edinburgh, Scotland, January 8th, 1862. He was educated in the Academy of that city. It was his early ambition to obtain a position in the Royal Engineers, but circumstances changed his plans. To perfect his knowledge of the French language, he studied a year in France. This was about 1878. In 1881 he came to America. In April of that year he found employment in the mechanical drawing-room of the Edge Moor Iron Works, where he was engaged until June, 1882. Doubtless his experience there brought him to realize the importance of a more thorough technical education as a preparation for his chosen profession, and, in the autumn of 1882, he entered the Massachusetts Institute of Technology, from which he graduated in 1886, with high rank in his class. The subject of his thesis was a design for a cantilever bridge over the St. Lawrence River at Lachine, P. Q. To familiarize himself with the requirements of the problem, he spent a vacation at Lachine.

There is abundant testimony that while at the Institute he was an earnest and faithful student, a leader among his fellows, and that he was held in the highest esteem by both faculty and students. During the vacation in 1884, he was employed in the bridge erection force of the Chicago, Milwaukee and St. Paul Railroad.

On the completion of his course at the Institute, he was at once offered a position in the drafting-room of the Boston Bridge Works, where he remained until October of the same year, at which time he accepted a position in the drafting-room of the Keystone Bridge Company. From January to May, 1887, he was engaged on special drawings for the terminals of the Minnesota and Northwestern Railroad at St. Paul, Minn. In May, 1887, he accepted a position with the Pittsburg Testing Laboratory, to inspect shop work at Athens, Pa., for the Poughkeepsie Bridge, inspecting also bridge-work at the Union Bridge Company's shops at Rochester, N. Y., and bridge material at the Elmira Rolling Mill. On January 15th, 1888, he entered upon an engagement as Assistant Engineer on the Cincinnati, Hamilton and Dayton Railroad, Joseph Ramsey, Jr., M. Soc. C. E., being Chief Engineer of the road. Upon Mr. Ramsey's retirement, to accept the position of Assistant to the President of the Cleveland, Cincinnati, Chicago and St. Louis Railroad, Mr. Wood became Acting Chief Engineer, and, in August, 1891, was appointed Chief Engineer of the Cincinnati,

* Memoir prepared by S. Whinery, M. Am. Soc. C. E.

Hamilton and Dayton Railroad system, a position he held with ability and honor until his death.

During this engagement extensive improvements were made on the road, embracing bridge renewals, the erection of an iron freight house at Cincinnati, and the construction of a large modern grain elevator at Toledo, O. The maintenance of way department was also under Mr. Wood's charge. During this time he resided in the village of Wyoming, a suburb of Cincinnati, and was one of three commissioners, Mr. Ramsey being another, appointed to design and construct a system of water supply for the village. After Mr. Ramsey removed to St. Louis, the mechanical and technical work of the commission fell largely to Mr. Wood, and to him was due in no small measure the practical success of the enterprise. He was re-elected to the position, which he held at the time of his death.

In the early part of the summer of 1895 Mr. Wood was taken sick with what his physician thought to be some disorder of the digestive system, and he was forced to discontinue all work for a time. Later in the season he was able to be at his office a few hours nearly every day, but there was no permanent improvement in his condition. As autumn came on he was confined to his home. Later his physician surmised that his malady was of a more serious nature than had been suspected, and a surgical operation, which was deemed advisable, disclosed that he was a victim of cancer of the stomach. He did not rally from the operation, and died on November 28th, 1895.

Mr. Wood became an Associate Member of the American Society of Civil Engineers July 4th, 1894. He was also a member of the Engineers' Club of Cincinnati, to which he contributed valuable papers. He took great interest in the American Society of Civil Engineers, and before his death collected notes for a paper for the Society on "The Construction of Grain Elevators." It is to be greatly regretted that he did not live to complete this paper, as it would have been of great practical value to the profession.

Mr. Wood was especially fond of structural work, and, while able and efficient in other departments, he developed unusual aptitude and talent in designing bridges and other structures. He was an energetic and tireless worker, who loved his profession next to his family and home. His friends have good reason to believe that had he not been cut off in his early manhood, he would have attained a front rank in his profession. In his business intercourse he was affable, courteous, considerate and just, and, at the same time, outspoken and decisive.

Letters to the writer since Mr. Wood's death, from instructors and fellow students at college, and from business and professional associates since his graduation, all bear strong testimony to his ability and sterling character. Mr. M. D. Woodford, President of the Cin-

cinnati, Hamilton and Dayton Railway Company, in a letter, dated January 13th, 1896, pays this high tribute to him as a man and a civil engineer:

"In the death of Mr. Wood, which was greatly deplored, the Cincinnati, Hamilton and Dayton Railway has lost a valuable official, whose eminent personal and professional qualities merited my most sincere appreciation.

"Mr. Wood commenced his service with the Cincinnati, Hamilton and Dayton Railway in January, 1888, as Assistant Engineer, which position he filled so creditably that in January, 1890, he was promoted to the position of Acting Chief Engineer, which afforded him an opportunity to demonstrate his ability, which was soon recognized by his appointment in August, 1891, to the office of Chief Engineer.

"Being well equipped by education and experience, he performed the duties of that office with marked success. Proficient in all branches of his profession, his forte was bridge engineering. He was also an expert in structural work. During the eight years of his connection with the Cincinnati, Hamilton and Dayton Railway Company much exceptionally important work was done under his supervision, which bears testimony to his excellent judgment and qualifications as an engineer, notably the planning and construction of our extensive Ivorydale yards, the erection of new freight houses at Cincinnati, the construction of a large grain elevator at Toledo, O., and the building of bridges over Silver Creek, Big Williams Creek and the Miami River.

"In his personal life he was esteemed and beloved for his splendid qualities of mind and heart, for his conscientious sense of duty and the high principles by which he was ever guided. Affable and courteous in his manners, his relations with all with whom he was brought in contact were at all times cordial and pleasant. Owing to his extreme modesty and his aversion to putting himself forward, only those who knew him intimately or were closely associated with him thoroughly appreciated his true value. Cut off by the Dread Reaper so early in his career, it is sad to think that a life of great usefulness and promise is ended just in its prime."

Mr. Wood's professional and business associates uniformly speak in the highest terms of praise of his personal and professional honor, his integrity, reliability and conscientious character. In his personal and social relations he was respected by all, and esteemed and beloved by his many friends for his sterling qualities of mind and heart.

Mr. Wood was married in May, 1890, to Miss Ruth Cowing, of Wyoming, O., who, with two children, survive to mourn the untimely loss of a most devoted husband and father.

FRANK BERESFORD, Jun. Am. Soc. C. E.*

DIED DECEMBER 12TH, 1887.

Frank Beresford was born at Cincinnati, O., on April 20th, 1861, and resided in that city for most of his life. He graduated from the civil engineering department of the University of Cincinnati in 1884, and immediately entered the engineer's office of the Cincinnati, New Orleans and Texas Pacific Railroad Company. His stay there lasted but a few months, however, for he entered the service of the Cincinnati, Hamilton and Dayton Railroad Company in September of that year, where he remained until his death.

His progress in his profession was quite rapid, for in the course of a year he rose from the position of Draftsman to that of Principal Assistant Engineer, with charge of the drafting, field work, bridge designing and inspecting. He was engaged in the discharge of these duties at the time of his death, which occurred on December 12th, 1887. His attainments as an engineer were exceptional for a man of his years, and his high character won him many friends. An intimate acquaintance, Joseph Ramsey, Jr., M. Am. Soc. C. E., writes as follows concerning him :

"In my opinion, his death was a great loss to the engineering profession, as I considered him one of the brightest and most promising engineers I ever had any connection with. He was a thorough-going, efficient and capable man, and had one of the most upright, honorable characters of any of my acquaintances."

Mr. Beresford was elected a Junior of the American Society of Civil Engineers on September 7th, 1887.

WILLIAM ALEXIS GEORGE EMONTS, Jun. Am. Soc. C. E.†

DIED NOVEMBER 5TH, 1887.

William Alexis George Emonts was born in 1847, at Spire, Bavaria, and was educated in the gymnasium at that place. He served as a lieutenant in the Bavarian army in the wars of 1866 and 1870-71, and during this time studied and practiced military engineering somewhat.

Soon after the close of the Franco-German war he came to this country, and in February, 1873, became an instrument man in the Engineer-

* Memoir prepared from papers on file at the House of the Society.

† Memoir prepared from information furnished by D. McN. Stauffer, Theodore Voorhees and William Hunter, Members Am. Soc. C. E., and from papers on file at the House of the Society.

ing Corps of the Philadelphia and Reading Railroad. In the fall of 1874 he became assistant to Mr. Henry W. Potts, Division Engineer on the Philadelphia and New York New Line Railroad, and retained this position until the completion of construction in June, 1876. He then became Assistant Engineer and Draftsman on the North Pennsylvania Railroad. In 1876 Mr. Emonts went to Germany and in 1879 to Central America.

During 1882 and 1883 he was engaged on the construction of the Shamokin, Sunbury and Lewisburg Railroad, and was located at Sunbury. During the latter part of 1883, he went to Philadelphia and was engaged on the surveys of the Schuylkill River East Side Railroad, until the conclusion of that work, some time in 1884. About 1885 he published a small pamphlet containing metric conversion tables.

Mr. Emonts was elected a Junior of the American Society of Civil Engineers on September 6th, 1876.

VERNON HILL GRIDLEY, Jun. Am. Soc. C. E.*

DIED SEPTEMBER 17TH, 1896.

Vernon Hill Gridley was born on a farm near Owosso, Mich., on February 11th, 1867. His early education was received in the country schools most convenient to his home. When he was twelve years of age the family left Michigan and settled in Monroe County, New York. From 1885 to 1887 he attended the Normal School at Brockport, and during the winter of 1887-88 he took the course in the Rochester Business University. The following year he had charge of the commercial department of a college or high school in Toronto, Canada, and after serving one year there he assumed a similar position in Fairfield Academy, Herkimer County, New York. In September, 1890, he entered the Rensselaer Polytechnic Institute, from which he was graduated with the degree of Bachelor of Science in 1893. He remained another year at the Institute, assisting Prof. Wm. P. Mason with his classes in chemistry, and in June, 1894, received the degree of Civil Engineer.

The first work which he did after leaving Troy was the taking of observations and the determination of the flow of water at the outlet of Lake George at Ticonderoga. In September he was appointed a leveler in the Department of City Works, Brooklyn, N. Y., and was employed in running a series of levels to determine the actual elevations of all the improved streets in the city. Early in 1895 he

* Memoir prepared by N. P. Lewis, M. Am. Soc. C. E.

entered a competitive examination for assistant engineers in that department, in which he obtained high rank, and was at once appointed. From then until the time of his death he was engaged upon the construction of street pavements in the city of Brooklyn.

He was elected a Junior of the American Society of Civil Engineers on February 4th, 1896.

He contracted typhoid fever in August, 1896, and died at St. Mary's Hospital, Brooklyn, on September 17th, 1896.

Mr. Gridley's brief professional career gave promise of a bright future. Quiet in manner and reserved in disposition, he impressed all who came in contact with him as a man of force and character. His industry, integrity and capability would have insured success in any field. His thoroughness in all matters of detail and his marked business capacity rendered his services especially valuable, both in designing and executing engineering work, while his admirable personal qualities won him many friends, who have learned of his untimely death with the keenest regret.

RUSSELL WADSWORTH HILDRETH, Jun. Am. Soc. C. E.*

DIED DECEMBER 23d, 1895.

Russell Wadsworth Hildreth was born in New York City on February 12th, 1865. He entered the School of Mines at Columbia College in 1881, and was graduated in June, 1885, with the degree of Engineer of Mines. Four months later he became a draftsman in the New York office of George S. Morison, Past-President Am. Soc. C. E., remaining there until March 1st, 1886, when he went to the Buffalo shops of the Union Bridge Company. There he was engaged in the inspection of the double-track and highway bridge across the Missouri River at Omaha, Neb., for the Union Pacific Railway Company, and two bridges for the Oregon Railway and Navigation Company. From April 1st to August 1st, 1887, he was Assistant Engineer on the Union Pacific Bridge at Omaha, and then went to the Athens shops of the Union Bridge Company to take charge of the inspection of a bridge across the Willamette River at Portland, Ore., for the Oregon Railway and Navigation Company.

On January 1st, 1886, the firm of Hildreth and Nettleton, inspectors of bridges, was formed by Mr. Hildreth and Mr. W. A. Nettleton. On September 1st, 1888, this firm became R. W. Hildreth and Company, owing to the withdrawal of Mr. Nettleton and the association of Mr.

* Memoir prepared from information furnished by Mr. P. S. Hildreth and from papers on file at the House of the Society.

P. S. Hildreth. Mr. Hildreth was connected with it up to the time of his death.

The work carried on embraced the inspection of many well-known bridge structures during manufacture and erection, including the New London and Red Rock bridges, general work for many of the principal cities, railroads and other corporations, and the preparation and examination of plans for steel work and the inspection of existing structures.

Mr. Hildreth was elected a Junior of the American Society of Civil Engineers on January 4th, 1888. He was a member of the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the Engineers' Club of New York. He died of typhoid fever and heart failure, after a brief illness.

ALBERT JACOB STAHLBERG, Jun. Am. Soc. C. E.*

DIED AUGUST 19TH, 1887.

Albert Jacob Stahlberg was born in Denmark in 1846. He was graduated in 1868 from the Polytechnic Institute (*Landbohøjskolen*) in Copenhagen as a "Forest Officer," and served in Sweden in 1868 and 1869 as Assistant on the work of regulating about 5 000 acres of woodland, which included the surveying and valuation of the property and the improvement of the streams running through it.

Late in 1869 he came to this country, and soon found employment as Assistant to Mr. George Beckwith, at that time the City Engineer of Bridgeport, Conn. In the summer of 1870, he entered the office of Messrs. Welton and Bonnett, of Waterbury, Conn., and under their direction was employed on the construction of water-works, railways and city works of various kinds. He remained in this office a number of years and then went to the Pacific Coast. For a time he was Assistant City Engineer of Los Angeles, Cal., and afterwards was connected at different times with the South Pacific Coast Railroad, the Oregonian Pacific Railway, and the Oregon and California Railroad.

In 1885 he visited Copenhagen on account of failing health, and remained in Denmark until his death on August 19th, 1887.

Mr. Stahlberg was elected a Junior of the American Society of Civil Engineers on March 4th, 1874.

* Memoir prepared from papers on file at the House of the Society.

WILLIAM HOWLAND ASPINWALL, F. Am. Soc. C. E.

DIED JANUARY 18TH, 1875.

William Howland Aspinwall, the founder of the Panama Railroad and Pacific Mail Steamship Companies, was the grandson of Captain John Aspinwall, one of the most prominent shipmasters of the New York merchant marine before the Revolution, and the son of John Aspinwall, a well-known merchant of that city in the early part of this century. He was born in New York on December 16th, 1807, and was educated in local private schools. At an early age he became a clerk in the mercantile house of G. G. & S. S. Howland, his uncles, and advanced so rapidly that in 1832 he was taken into partnership. About five years later Gardner and Samuel Howland withdrew from the active management of the affairs of the house, and its name was changed to Howland & Aspinwall. The business was very extensive, particularly with countries on the Pacific and Mediterranean coasts, the East and West Indies, and England, and the firm owned at one time over fifteen ships, including several Liverpool packets.

It was this wide range of business relations that led Mr. Aspinwall to appreciate the importance of the Panama route. California had just been annexed to the United States, and he believed that better means of communication across the Isthmus of Darien would prove profitable to those furnishing it, as well as a great aid in developing American commerce. Congress had sold contracts for carrying mail by steamers from Chagres to New York and New Orleans, and from Panama to San Francisco, but the persons who obtained them were unable to carry out their provisions. Finally George Law, the New York street railway builder, bought the Atlantic line, and Mr. Aspinwall obtained control of that on the Pacific. The former was then considered a good investment, but Mr. Aspinwall's commercial acquaintances regarded his purchase as a very poor bargain. It was merely part of a great undertaking, however, which developed under his management into a very profitable business, of great importance to commercial interests. In 1848 the Pacific Mail Steamship Company was chartered in New York State to carry out the mail steamer contracts, and Mr. Aspinwall remained its president until his retirement from active business in 1856.

This company carried out but half his plans, however, for he recognized, as soon as the rush for California began, after the discovery of gold on the Pacific Coast, that some method of solving the problem of rapid transit across the Isthmus, given up as hopeless by early English and French investigators, must be devised. His idea was to build

a railroad across the narrow ridge of land. He found in John L. Stevens an associate familiar with the country who was willing to make an exploration of the route in company with an engineer. The result of this investigation showed that such a line could be built, and Messrs. Aspinwall, Stevens and Henry Chauncey made a contract with the authorities of New Grenada to build a railroad. The Panama Railroad Company was incorporated under the laws of the State of New York to take over these obligations, and Mr. Stevens was elected president. A contract was made with George M. Totten and John C. Trautwine for the construction of the line, and work was begun in May, 1850. It progressed slowly on account of the great natural difficulties of topography and climate, but was finally opened early in 1855. Its Atlantic terminus on Navy Bay was an uninhabited spot at the time the railroad was projected, and was for some time overshadowed in size and commercial importance by the neighboring town of Chagres. As the railroad progressed, however, it became an important place and was named Aspinwall, after the man whose enterprise had developed that region. This name was employed by English-speaking people until a few years ago, when the Colombian authorities refused to transmit mail matter to it unless addressed Colon, the Spanish name of the place. In the first seven years of operation of the road, the net earnings were nearly \$6 000 000, a good proof of its founder's business sagacity. As a mark of appreciation of the work of the three projectors of the line, Messrs. Aspinwall, Stevens and Chauncey, the directors of the company erected, a few years before Mr. Aspinwall's death, a large monument at Colon, on the base of which their busts were carved. This monument stands on the beach in front of the company's property, and is one of the prominent features of the town.

After these great companies were placed on a thoroughly sound basis Mr. Aspinwall practically retired from business. Much of his time was spent in travel, and he took particular pleasure in collecting pictures and in improving his country estate near Tarrytown.

Mr. Aspinwall was elected a Fellow of the American Society of Civil Engineers on July 9th, 1870. He died on January 18th, 1875.

GEORGE WASHINGTON CASS, Jr., F. Am. Soc. C. E.*

DIED MAY 21st, 1888.

George Washington Cass, Jr., was born on his father's lands, near Dresden, Muskingum County, Ohio, on March 12th, 1810. He was the oldest child of George Washington Cass and Sophia Lord, and

* Memoir prepared by Cass K. Shelby, Esq.

grandson of Jonathan Cass, a Captain of volunteers in the Continental Army, and afterwards a Major in the U. S. Army. Jonathan Cass lived in Exeter, N. H., and moved with his wife, Mary Gilman, and family in 1800 to Ohio, where he settled finally on the Muskingum River near Dresden. Owing to the schools in that new region being of the most elementary character, George W. Cass, Jr., was sent to Detroit, Mich., in 1824 for the purpose of being educated at the Detroit Academy, then under the charge of Rev. Ashbel Wells, and while there he lived with his uncle, Lewis Cass, at that time Governor of Michigan Territory. Four years later he obtained an appointment from his native state as a cadet at the U. S. Military Academy at West Point, and graduated from there in June, 1832, at the head of his class in the principal studies, and among the first five in general academic studies.

Instead of receiving the usual two months' leave of absence on graduating, he was at once ordered to report to General Scott, then in New York organizing an army to proceed against the Indians, who were collected in large numbers in the Northwest under Black Hawk. Although having only the rank of cadet, he was placed in command of a company of infantry just recruited into service, and assigned to that portion of the army under General Twiggs. On the way to the frontier the command of General Twiggs was so much reduced in numbers by the Asiatic cholera that a number of companies were broken up for the purpose of filling others to a proper complement, and thus, the number of officers being in excess of the demand for service, Capt. Cass was transferred to the Department of Topographical Engineers. He served six months in this department, and was then transferred to the Department of Military Engineers, in which he remained until October, 1836, when, resigning his position, he received from President Jackson an appointment of Civil Engineer on the National Road, in which capacity he continued until the completion of that road in the states of Virginia, Maryland and Pennsylvania. During this service Capt. Cass erected over Durlap's Creek, a tributary to the Monongahela River, the first cast-iron bridge ever built in the United States.

He was an early and persistent advocate of the improvements of the Monongahela River by locks and dams, and contributed to the procuring of the charter and organization of a company. As its engineer, he made the survey and located and superintended the construction of locks Nos. 3 and 4. After the suspension of the work by the inability of the State of Pennsylvania to pay its appropriation, and the sale of the State stock to private parties, he was a member of the Board of Managers, and was actively instrumental in organizing a company from the new shareholders and the framing of a contract which insured the completion of the work in 1844.

On the completion of the Monongahela improvements to Brownsville, Pa., he organized the first steamboat line on that river, and also the first fast transportation lines across the mountains by relays of teams similar to stage lines, thus building up a large carrying trade between the East and the West *via* the Monongahela River and Pittsburgh.

In 1849 he established the Adams Express across the mountains from Baltimore, effected the consolidation of all the Adams Express lines between Boston and St. Louis, and south to Richmond in 1854, and in the year following was elected President of the consolidated company, with offices in Pittsburgh, Pa.

In January, 1856, he was elected President of the Ohio and Pennsylvania Railroad Company, then possessing a road completed to Crestline. This line was finally extended to Pittsburgh and Chicago, and became the Pittsburgh, Fort Wayne and Chicago Railway. Mr. Cass remained at the head of this company for twenty-five years. In 1859 he was appointed a member of the Board of Visitors to the U. S. Military Academy. He was also president of the Continental Improvement Company of Pittsburgh which built the Grand Rapids and Indiana Railroad.

Mr. Cass was one of the Commissioners named by Congress to organize the Union Pacific Railroad Company, and was a member of the first Board of Directors of that company. He declined the office of treasurer and president. He also became a member of the Smith syndicate which took possession of the franchise and debts of the Northern Pacific Railroad Company in 1866, and became greatly interested in the development of the Northwest. When the Northern Pacific Railroad was constructed and put into operation, he became its president on October 1st, 1872, and transferred his residence from Pittsburgh to New York City. He was at this time also President of the Southern Railway Security Company which controlled the properties of the East Tennessee, Virginia and Georgia Railroad and other southern lines. While connected with the Northern Pacific system Mr. Cass bought a tract of land seventeen miles west of Fargo, No. Dak., having in view the cultivation of wheat in that region. At the same time Mr. Charles P. Cheney, of Boston, bought lands adjoining, and jointly they engaged the services of Oliver Dalrymple to superintend the united estate, which became known as the famous Cass-Cheney farm. Mr. Cass resigned his office of president of the Northern Pacific Railroad in 1875 to take the receivership of that company, and after the reorganization in August following he went to Europe for a rest. With the exception of a visit home the next year, he remained abroad until the spring of 1881.

Mr. Cass did not again engage in active business after severing his connection with the Northern Pacific. He continued to live in New York City, however, where he died March 21st, 1888.

George W. Cass married first, January 5th, 1835, Louisa Smith, second daughter of George and Mary (Kennedy) Dawson, of Brownsville, Pa., and had by her one child, a daughter. His wife died at Dresden, O., seven years after, and he married secondly, September 14th, 1843, Ellen, the third daughter of George Dawson, of Brownsville, and had by her five sons and six daughters.

He was elected a Fellow of the American Society of Civil Engineers on March 30th, 1871.

THOMAS C. DURANT, F. Am. Soc. C. E.*

DIED OCTOBER 5TH, 1885.

Thomas C. Durant was born in Lee, Berkshire County, Mass., in 1820, and came of a family which had played a prominent part in the early history of that region. He studied medicine at the Albany Medical School and practiced for about three years, but finally gave up the profession to enter upon the business career in which he subsequently achieved remarkable success. He became a member of the Albany shipping firm of Durant, Lathrop & Company, which had branches in New York, Chicago and Boston, and carried on a large business. Dr. Durant was the head of the New York branch. He was the owner of a number of vessels, leased many more, and his European trade, particularly in wheat, was very profitable up to about the time of the French Revolution of 1848.

The shipping interests with which he was connected led him to recognize the possibilities of the West, and made him a strong advocate of internal improvements which would open up the resources of that region. He was actively engaged in promoting the interests of the Michigan Southern Railroad, and was one of the leading contractors for the construction of the Peoria and Bureau Valley and the Mississippi and Missouri Railroads. He made surveys for a railway line in the Platte Valley several years before the organization of the Union Pacific Company, and in 1863 had surveys made at his own expense from Omaha to the basin of Great Salt Lake. In 1863 he took an active part in raising the \$2 000 000 stock subscription required by Congress before the Union Pacific Company could be organized. His active interest in the work continued until the last rail was laid, the financing of the great undertaking receiving most of his attention.

As soon as this line was finished Dr. Durant began building the Adirondack Railroad, of which he was the chief stockholder, President and General Manager at the time of his death.

He was elected a Fellow of the American Society of Civil Engineers on November 18th, 1870.

* Memoir prepared in the office of the American Society of Civil Engineers.

SIDNEY DILLON, F. Am. Soc. C. E.*

DIED JUNE 9TH, 1892.

Sidney Dillon, the well-known financier and contractor for railroads having a total length variously estimated at 2 500 to 3 000 miles and costing from \$75 000 000 to \$100 000 000, was a farmer's boy in early life. He was born on May 7th, 1812, in Northampton, Montgomery County, N. Y., where the family had resided for several generations. His grandfather was a Revolutionary soldier, and was present at the surrender of Burgoyne. Young Dillon was brought up like most boys in similar conditions at the time, receiving as good an education as the local schools afforded.

His railroad career began as an errand boy on the Mohawk and Hudson Railroad from Albany to Schenectady, and when this road was finished, he was employed in a similar capacity on the Rensselaer and Saratoga Railroad. Later, he became an overseer for Crane & Clark, who had a contract on the Boston and Providence Railroad near Sharon, and remained with them for two years, until the contract was completed. Then he was made a foreman for the same firm on its contracts on the Stonington road in Connecticut and on heavy rock work near Charlton, Mass., on the Western Railway, now part of the Boston and Albany line. In the latter position he had the good fortune to become intimately acquainted with Capt. W. H. Swift, at that time the engineer in charge of work. Capt. Swift took a strong interest in the young man, and when it came time to put in bids for new work urged him to make tenders on his own account. Mr. Dillon had little money at the time, but he thought he saw his way clear to undertaking a small section near Hinsdale. His bid was accepted and the work was completed satisfactorily in 1840.

This was the beginning of a contracting career of unusual extent and success. Mr. Dillon is described by those who were acquainted with him about this time as an unusually fine leader of men. Over 6 ft. tall, heavily built yet active, and speaking in a direct, incisive manner, he conveyed the impression of a man who knew what to do and how to do it, and was fully able to command others in carrying out his plans. His second contract was on the Troy and Schenectady Railway, where he took some heavy work in clay about 2 miles from Troy, which was carried out by means of a steam shovel. Then he became a member of the firm of Boody, Ross & Dillon, which built 6 miles of the Cheshire Railroad in Vermont and the Hartford and Springfield Railway, 26 miles long, part of the payment of the latter being made in stock. At this time he also had an individual contract to construct

* Memoir prepared in the office of the American Society of Civil Engineers.

6 miles of difficult line on the Vermont and Massachusetts Railroad. As a partner in the firm of Dillon & Pratt he was interested in the construction of 7 miles of the Rutland and Burlington Railroad near Burlington, Vt. A little later Boody, Ross & Dillon built the Central Railroad of New Jersey from Whitehouse to Easton, a distance of 29 miles, taking their pay entirely in stocks and bonds. The work was difficult, but was finished in two years by means of steam shovels. The firm was also engaged about the same time in widening 20 miles of the Morris Canal, and a little later contracted to build the Boston and New York Central road. The latter company failed after 30 miles were built, and the contractors were forced to attach and sell the rolling stock and other visible assets to obtain part of the money due them. Afterwards the company built 100 miles of the Philadelphia and Erie road west from Lock Haven; and, somewhat later, Mr. Dillon was interested, as a member of the firm of Dillon, Clyde & Chapman, in contracts on the Erie and Cleveland, the New Jersey Central and the Morris and Essex Railroads.

In 1865 he began his active association with the Union Pacific Railway, and during the next four years his wide experience as a railroad builder was of much value to the men in charge of that great enterprise. He was present at the ceremony of laying the last rail in 1869, and the silver spike with which the road was completed remained in his possession until his death. During this time he was also interested with John I. Blair in Iowa railroads, and had a 70-mile contract on the construction of the Boston, Hartford and Erie Railroad, which, however, was not completed on account of the lack of funds of the railroad company. A little later he had contracts on the Connecticut Valley, the Chillicothe, Council Bluffs and Omaha, and the Canada Southern roads, built the Paterson branch of the Morris and Essex line and was engaged on many smaller works.

All these contracts brought Mr. Dillon a large fortune, which was principally invested in railroad securities. The management of these investments gradually occupied a larger part of his time, and after 1870 he was known chiefly as a financier. He was a director of the Union Pacific Company for many years and its president during a considerable part of this time. He was associated with Jay Gould in the management of many of the properties controlled by the latter, and was a director in the Western Union Telegraph, the Manhattan Elevated Railroad, the Missouri Pacific Railway, the Pacific Mail Steamship, the Chicago, Rock Island and Pacific Railway, the Wabash Railway, the Canadian Southern Railway, the Wheeling and Lake Erie Railroad Companies and many smaller organizations.

Mr. Dillon was elected a Fellow of the American Society of Civil Engineers on March 26th, 1870. He was married in 1841, and left two daughters, four grandsons and one granddaughter.

HENRY FARNAM, F. Am. Soc. C. E.*

DIED OCTOBER 4TH, 1883.

The career of Henry Farnam, prominent as an engineer, contractor and railroad president during the building up of the Central States, is remarkable for the fact that for nearly thirty years his work was of a routine nature, and for most of the time connected with a more or less financially unsuccessful undertaking. This long period of apprenticeship, if it may be called such, brought its fruits, however, in thirteen years of unusually successful operations on a great scale, yielding pecuniary returns commensurate with their importance, and enabling Mr. Farnam to spend the last twenty years of his life in a retirement marked by many gracious acts.

He came of a Connecticut family that settled in Scipio, Cayuga County, N. Y., late in the last century. The country was then practically a wilderness, and the settlers were pioneers in many respects. Henry Farnam was born November 9th, 1803, and soon displayed an unusual fondness for books and a lack of interest in farm work. For a short time he lived with a relative, a physician, to learn if he had a taste for the medical profession, but it was soon found that this was not the case. His favorite studies were mathematical. With meager instruction and few text-books, he mastered the elements of trigonometry and surveying before he was sixteen.

In 1821, he at last found an opening that might lead to something to his taste. The Erie Canal was then under construction, one section of which was in charge of David Thomas, to whom the young man applied for a position on a surveying party. The only place then vacant happened to be that of camp cook, which Mr. Farnam at once accepted, so as to be on hand when vacancies in the surveying staff might occur. He soon rose to be Assistant Engineer, and was connected with the canal until the fall of 1824, spending the winter months teaching school. It was during this engagement that he contracted a malarial disease that for some time threatened his life. This was finally cured, however, and was practically the only sickness he had until his last few years.

From 1825 until 1850 Mr. Farnam was connected with the canal running from New Haven to Westfield. This work was undertaken in 1822 by the Farmington Canal Company, but actual construction was not begun until three years later. Davis Hurd was Chief Engineer of the company, and he offered the position of Assistant to his relative, Mr. Farnam. It was at once accepted, and in 1827, on the retirement

*Memoir prepared from a biography written by Henry W. Farnam, Esq.

of Mr. Hurd, was followed by promotion to the position of Chief Engineer. The canal was part of the system of waterways eventually extended from New Haven to Northampton, and controlled by the New Haven and Northampton Canal Company. It was largely built and managed by Mr. Farnam as Chief Engineer and Superintendent, whose experience in this work must have been an anxious one. The balance sheet always showed losses, which were attributed, like those of other New England canals, by its chief financial backer, Joseph E. Sheffield, to two facts—that little passenger travel could be secured, and that the canal never carried on transportation itself, but simply collected tolls, requiring a much larger volume of business to pay dividends than would be needed by a railroad.

By 1845 the company's stockholders were convinced that the canal could not be made to pay, and Mr. Farnam proposed to build a railroad along its line, abandoning the waterway. Mr. Sheffield, then actively engaged in organizing the New York and New Haven Railroad Company, took up the idea, and with his co-operation the railroad was built, reaching Plainville in 1848, and Tariffville and Collinsville in 1850. The New Haven and Hartford Railroad was then in operation. The competition between the two lines was strong, and various deals were made between the roads, which were disappointing to both Mr. Sheffield and his chief engineer. Both withdrew entirely from eastern railroading, but that Mr. Farnam's relations with the New Haven and Northampton Company remained harmonious to their termination is evinced by the following extract from a resolution passed at a meeting of the stockholders in 1850:

"For the uniform fidelity with which Mr. Farnam has performed all the duties devolving upon him; for the unimpeachable integrity with which the many thousand dollars that have passed through his hands have been expended; for the unshaken confidence with which he carried forward these works under very great difficulties; and for the heavy personal responsibility which he often assumed to maintain the works, when otherwise they would have been sacrificed, this Company entertain the highest consideration."

Although these twenty-five years were full of arduous works, of long patrols in his buggy along the line of the canal in all sorts of weather, and were rewarded with but a small salary, yet they had one important result, the formation of enduring friendships with men of great business influence and sagacity, particularly James Hillhouse and Mr. Sheffield, and it was in partnership with the latter that Mr. Farnam made his first noteworthy success as a contractor.

In 1850 Chicago was a place of 30 000 inhabitants, built in a straggling fashion on the swamp about the mouth of the nearly stagnant stream known as the Chicago River. Its facilities as a terminus for steamboat navigation were admirable, but otherwise it possessed few attractions. Two years before, the Illinois and Michigan Canal had

finally been completed from Chicago to La Salle, thus connecting Lake Michigan with the Mississippi Valley. The Michigan Southern Railroad had then reached Hillsdale, 167 miles from Chicago, and a section of the Galena and Chicago Union Railroad ran from Chicago to Elgin. William B. Ogden was then President of the latter road, and at his invitation Mr. Farnam went west, with a view to becoming interested in that undertaking. The possibilities of the country impressed him so favorably, however, that he did not care to commit himself to any one project at that time.

He made another visit a little later in company with Mr. Sheffield, and in their journey through the country were much attracted by the future for a paper railroad between Rock Island and La Salle. When the road was chartered in 1847, its projectors believed that it could not compete with the canal from Chicago to La Salle, but would stand a good chance of securing a profitable traffic from the latter city westward, in competition with the natural waterways. The experience in Connecticut showed, however, that such a project was not the right one, but the firm of Sheffield and Farnam offered to build the road if the charter could be amended to give the right to run through to Chicago.

Before this contract was completed, however, the new firm was given an opportunity to show its capabilities. The Michigan Southern road then stopped at Hillsdale, on account of financial weakness. John B. Jervis was Chief Engineer of the company, and he wanted Mr. Farnam to become Superintendent of the completed part of the line. The latter declined the proffered position, but agreed that his firm would build the road into Chicago, a daring offer in those days. The contract was made, and in March, 1852, the first train from the East entered Chicago over this line. Shortly afterward the Michigan Central built through to the city, which, under the stimulus of these new facilities for transportation, soon began to develop marvelously.

The legislative preliminaries in the Rock Island and La Salle project were meanwhile carried on under the general supervision of the firm. In 1851, the new charter was obtained and the name of the corporation altered to the Chicago and Rock Island Railroad Company, and soon after John B. Jervis was chosen President, and William Jervis Chief Engineer. The surveys were completed in August, and the next month the formal contract with Sheffield and Farnam was closed for building and equipping the entire road, about half the payment to be made in 7 per cent. bonds. Late in February, 1854, the first train ran from Chicago to Rock Island, and in July the road was formally turned over to the company, eighteen months before the time specified in the contract. The firm also built during this time, in company with several other parties, the Peoria and Bureau Valley Railroad, a branch of the Rock Island system. The completion of these contracts

was celebrated as an event of national importance. Sheffield and Farnam took a party of over a thousand from Chicago to Rock Island, up the Mississippi to Fort Snelling, and back to Chicago. Six days were spent on the excursion, and among the guests were President Fillmore, George Bancroft, Governor Baldwin of Connecticut, Thurlow Weed, Epes Sargent, Charles A. Dana and Samuel Bowles.

Before the completion of the Chicago and Rock Island line, Mr. Farnam had investigated the opportunities for railroads in Iowa, and was convinced that they offered many openings for profitable undertakings. The first thing to be done, however, was to cross the Mississippi, and the Rock Island Bridge Company was formed to do this. The bridge built, the first over the river, was a wooden structure and aroused great opposition. Boats collided with the piers and their owners brought suits for damages, and it was once set on fire. Then the United States Government sued out an injunction against it, but finally the company triumphed over all obstacles and a railroad connection across the river was assured.

The Iowa road was chartered as the Mississippi and Missouri Railroad, and formed part of a single system of which the Rock Island Bridge and Chicago and Rock Island Railroad were the other links. Mr. Sheffield retired from business about this time, and the firm of Farnam and Durant was formed with Dr. Thomas C. Durant. In May, 1855, a contract was taken by the firm for the construction of a road from Davenport to Iowa City, with a branch to Muscatine. A period of commercial depression came on about this time, and during the crisis of 1857, the firm came dangerously near ruin. This was finally avoided, and the road extended to Grinnell, 120 miles from Davenport. During this time Mr. Farnam was acting as President of the Chicago and Rock Island Railroad Company and of a bank, and was also actively engaged in promoting the project of a railway to the Pacific Coast. He finally became one of the incorporators of the Union Pacific Company, but soon found himself out of sympathy with the proposed methods of conducting the enterprise and ceased to have anything to do with it. He continued, however, to take part in railway affairs until June 4, 1863, when he resigned the presidency of the Rock Island Railroad Company, and retired from active work.

Five years of subsequent life were spent in travel and the remainder at his home in New Haven. He was too advanced in years to offer his personal services to the country during the Civil War, but he contributed financial support, and, with his wife, cared for wounded and sick soldiers in Chicago. He made many gifts to Yale College, gave the city of New Haven one of its most beautiful drives, and in many ways used his large wealth for the advantage of others.

His death occurred on October 4th, 1883, and was due to a stroke of paralysis. Mr. Farnam was elected a Fellow of the American Society of Civil Engineers on November 14th, 1872.

ALFRED KRUPP, F. Am. Soc. C. E.*

DIED JULY 14TH, 1887.

Alfred Krupp's career as an iron master was laid out for him by his father, but the success he achieved was solely his own, and the reward of unremitting labor and bold business enterprise. His father, Friedrich Krupp, was for many years among the most prosperous residents of Essen on the Ruhr, then a little town of about 4 000 people. His great purpose had been to learn the art of making cast steel, which was practiced in England as early as the middle of the last century. During the Napoleonic wars it was difficult in Germany to secure enough of this metal to meet the demands of the manufacturers of fine tools, and many Germans tried to learn the secret. Friedrich Krupp struggled along for years and finally found it. He made steel of good quality, and in an official Prussian report of 1822, it is stated that his product "has been carefully examined by the Bureau of Manufactures and Commerce at Berlin, and has been found, in adaptability and intrinsic excellence, fully equal to the best English steel, in some respects even preferable." But in spite of the good quality of the metal, the demand was very light, and there was not business enough to pay expenses. The pleasant home had to be abandoned, and the family went to live in a small one-story laborer's cottage still standing in the heart of the immense establishment which the genius of the owner's son reared around it.

It was in this humble cottage that Alfred Krupp lived while laying the foundations of the industry that is now known the world over. In 1873 he had an engraving made of the house, copies of which were distributed to the workmen with a note saying, among other things:

"Fifty years ago this laborer's cot was the refuge of my parents. May no workman of ours ever experience the sorrow that then enshrouded us! For twenty-five years the issue was in doubt, an issue which has since then, by degrees, so astonishingly rewarded the privations, the struggles, the confidence and the perseverance of the past. May this example stimulate others in distress, may it increase the respect for small domiciles and the sympathy for the greater cares that often dwell therein."

Shortly before Friedrich Krupp's death, he told his son the secret of making cast steel. In 1826, his widow announced that the works would be continued under the former name and manufacture "cast steel in rods of any thickness, rolled plates and forgings after drawings or models, such as mint dies, shafting, spindles, shear-blades, rolls,

* Prepared chiefly from a biographical sketch by Capt. O. E. Michaelis, U. S. A.

etc., also tanners's tools." The management of the little plant, which had been a commercial failure under Friedrich Krupp, passed into the hands of his son before the latter was fifteen years of age. With two workmen he labored daily at the forge, and his condition at the time is indicated best by his own words:

"Working hard, often all night long, my food being for the most part potatoes, coffee, bread and butter, but no meat, I felt all the responsibility of a harassed father of a family. For twenty-five years I persevered, until at last, under gradually improving circumstances, I conquered a decent living. My most vivid impression of the distant past is the recollection of the long-continued, ever-threatening danger of ruin, and its avoidance through patience, self-denial and labor."

For a period of about fifteen years, just enough was earned to pay the workmen and living expenses. Under the direction of an uncle, he studied book-keeping and mercantile methods, and gradually extended the market for his steel. In 1832 he had ten workmen, and somewhat later made his first important commercial success, the sale of English patents for a cast-steel roller die. All his spare money was apparently devoted to increasing his plant and for journeys of investigation among English steel works. Early in the forties, he began experimenting with cast-steel guns, and by 1845 the number of employees had risen to 122, although during the agricultural depression and political troubles of 1848, the number fell off for a time. During the latter year Alfred Krupp assumed entire control of the establishment, his brother Friedrich withdrawing, and in a short time the works began to grow in size and importance at a surprising rate. In 1848 the number of men was 72; in 1858, 1 047, and in 1863, 4 185. The most important advances were made between 1850 and 1860. In 1851, Krupp showed at the London Exhibition a cast-steel block weighing over 2 tons, something unheard of in England at the time; in fact, it was so frequently reported that the steel was not of good quality and would fly to pieces like cast iron under the hammer, that a piece had to be cut from the block and forged on the anvil to prove its quality. The next year was marked by the Krupp invention of a method of manufacturing weldless railway ties, which proved very profitable.

In 1853 Krupp married Bertha Eichhoff and left the little cottage, where he had lived during the building up of the works, for an unpretentious two-story house adjoining it. It was here that the present owner of the works, Friedrich Alfred Krupp, was born, and here the family lived until 1864, when they moved to a larger house, also within the limits of the works. Afterward a small country home, a few miles from Essen, was purchased and gradually enlarged. It is worth noticing that for more than forty years the builder of this great establishment lived within its boundaries, most of the time in a house far inferior to that occupied by many of his employees.

The successful exhibit at London was far surpassed by that at Paris in 1855, where a block weighing 5 000 kilos was shown, which received a gold medal. By this time the manufacture of guns was well advanced, and a 12-pounder shell gun which was among the exhibits was subjected to many trials. This did not lead to an order, however. The first country to order guns was Egypt, in 1857, followed soon by Brunswick and Prussia. About this time he designed his first rifled breech-loaders, which were adopted by Prussia in 1861. In 1868 there was a competitive trial at the Tegel Proving Ground near Berlin between Krupp breech-loaders and Woolwich muzzle-loaders, in which the former proved far superior. From that time on the Krupp ordnance was recognized as among the best, and its service a few years later during the Franco-German war showed that the peace tests were equalled by the hard trials of actual fighting.

The numerous institutions founded by Krupp for the benefit of his employees have been often described and need not be mentioned here. His idea was that "with assured and sufficient earnings, with content and comfort at home, every individual can enjoy the very fact of living," and he endeavored to furnish these conditions as far as possible. His plans have much of the paternalism for which German institutions are noteworthy, but their success is demonstrated by the comparative absence in Essen of labor troubles, anarchistic and even socialistic-democratic agitations, as compared with other important industrial centers in that country.

The success which was achieved by this man was remarkable. In sixty years he won his way from being the boy manager of a nearly insolvent forge, worked by two men besides himself, to the proud position of the heaviest individual tax-payer in the German Empire and the sole owner of a business on which 60 000 people depended for a living. Honors and orders of all sorts were given him by many governments, yet he rarely wore a decoration. Kings, emperors and princes were often among his guests, yet he declined the offer of a title, and preferred to retain the name which his energy had made a guarantee of good material and workmanship.

Early in 1887 his health began to fail. For some years, he had been gradually withdrawing from the business of the works, and leaving the management to a committee of technical, commercial and legal experts of which his son was a member, so when his end drew near there was no hitch in the operations of the establishment, a result he had worked for during a number of years. His strength finally gave out, and on July 14th, 1887, he passed away gently, in the seventy-fifth year of his age.

He was elected a Fellow of the American Society of Civil Engineers on June 14th, 1870.

WILLIAM C. KINGSLEY, F. Am. Soc. C. E.*

DIED FEBRUARY 21ST, 1885.

William C. Kingsley was born in Fort Covington, Franklin County, N. Y., July 31st, 1833. His father was a farmer, and Mr. Kingsley's boyhood was passed uneventfully upon the farm, where he rendered faithful, painstaking assistance during the summer months. In the winter he attended school, learning readily and showing marked aptitude for mathematical work and great fondness for history.

Before he reached manhood he had acquired such an education as the village school could furnish, and, as he was an omnivorous reader, he had stored away much valuable knowledge gained from works borrowed from neighbors and otherwise obtained, in addition to that acquired at school. Young Kingsley realized very early in life that, attractive as the life of a farmer might be to some, it was not the life for him, and he resolved to leave the parental roof-tree and strike out for himself, a resolution which, once having made, he quickly put into execution.

He started out with the benedictions and blessings of his parents, who had reluctantly consented to his going. He had no definite plan of action, but a fixed purpose to do something which should at least satisfy the yearnings of his soul and enable him to exert to the utmost the powers which he knew were his. He found employment immediately with a railway company which was engaged in constructing a railroad in Westmoreland County, Pa. His duties were clerical, but he brought so much intelligence, fidelity and zeal to bear on their performance as to stamp him at once as a man of no mean ability; but, just as his employers were about to show their recognition of his excellent service, typhoid fever prostrated him, and he lay precariously ill for many weeks. Good habits and previous good health proved their efficient help in assisting him through the terrible illness, but his recovery was slow and the importance of outdoor exercise apparent. Unwilling to remain idle one hour longer than was absolutely necessary, young Kingsley applied for and secured a position as teacher in a school in New Alexandria, without, however, any idea of choosing teaching as a profession. He was singularly successful, acquiring vast influence over his pupils, who recognized in him a master who was a friend as well. His labors in the schoolroom were marked by the same conscientious devotion and industrious, painstaking efforts as had characterized everything he had undertaken from his earliest childhood. During his incumbency as teacher an emeute occurred among the scholars, led by some of the older, more obstreperous pupils. The

* Memoir received through C. C. Martin, M. Am. Soc. C. E.

skill, judgment and courage with which he met the matter attracted the attention of Col. Snodgrass, who had been accidentally a witness to the fracas. Recognizing immediately the inherent qualities which had enabled the young teacher to so successfully and triumphantly terminate a rather serious difficulty, Col. Snodgrass determined to befriend the young man, and to that end tendered him a position as bookkeeper. Mr. Kingsley accepted the offer, and at once entered upon his duties.

Col. Snodgrass was at this time engaged in building a large canal in Wyoming, Pa. The region thereabout is extremely wild and mountainous, conditions which rendered the work one of great difficulty, which was materially increased by the continual disturbances occurring among the employees, who were, in many cases, as wild as the country about them. Strikes were frequent, and race and clan fights numerous. When young Kingsley arrived, disorganization was complete. He at once, in the absence of his employer, took charge, and in a short time succeeded in restoring order and bringing about a more amicable feeling among the men; gave a new impetus to the work, which had been dragging along for several years, and in a year and a half brought it to a profitable and successful completion.

He remained for eighteen months afterwards with Col. Snodgrass, executing meanwhile for him a contract for the construction of the great tunnel between Altoona and Johnstown. Upon the completion of this work Mr. Kingsley felt himself master of the contracting business, and determined to go west on a tour of observation. He so-journed in Illinois and Wisconsin for some time, and built railroads and other works, always with great success.

Returning to the East, he settled in Brooklyn, then little more than an extensive village. He was immediately recognized as a man of unusual ability and promise, though but twenty-four years of age.

The water-works of Brooklyn were then in process of construction, and a part of the work was sublet to William Kingsley, and the manner in which his part was performed placed him in the front rank among contractors and engineers. About this time he entered into partnership with Col. Abner C. Keeney, a man of great energy and business capacity, and one who proved himself invaluable as a co-laborer and friend. As such he remained until his death. The firm thus formed was awarded the contract for sewerage the city of Brooklyn, and more than 65 miles of subways were built under the streets. At the same time, Messrs. Kingsley and Keeney built the Wallabout improvements, and railway lines in Pennsylvania and New York. The Hudson Avenue and the Third Avenue sewers, the stone walls around Central Park in New York, and Washington Park in Brooklyn, were also built by this firm. The greatest of their undertakings as partners was the storage reservoir at Hempstead, N. Y. Many difficulties in excavating and other matters had to be met and overcome in order

to create the basin, which was built to hold a million gallons of water in reserve. When completed it was flawless, and remains so to-day.

To William C. Kingsley, more than to any other man, are Brooklyn and New York indebted for the great bridge which spans the East River. He conceived the project, and, after consultation with an eminent engineer, who framed the tremendous scheme, set himself to work to overcome monster objections and obstacles of every kind, to effect legislation in favor of the great enterprise. Not once did he falter, though assailed and vilified and hampered in all possible ways. For two years he lived with this thought uppermost in his mind, always actively urging it, and finally securing the necessary legislation authorizing the commencement of the work. A private corporation was first formed, with the two cities as contributors, Brooklyn contributing two-thirds, and New York one-third, to the capital stock, and the incorporators subscribing half a million dollars themselves as an earnest of their faith in the project. Of this sum Messrs. Kingsley and Keeney subscribed over three-fifths. It is not the purpose of this memoir to enter exhaustively into the various stages of the construction of the bridge. Suffice it to record that colossal obstacles and hindrances—the result in some instances of ignorance, in others of jealousy—were constantly being placed in the way as barriers to its successful termination. A less courageous man than William C. Kingsley would have failed in the work, but neither the virulence of his enemies, nor the ignorance of the many who sought to prove its impracticability, served to turn him a hair's breadth from the path he had laid out. The bridge must be built, and he must not and would not rest until it was an actuality. From a private enterprise, the building of the bridge became a public undertaking, largely through the influence of Mr. Kingsley, who foresaw its necessity to insure the success of the undertaking.

He became a member of the Board of Trustees, and of every successive board he continued a member. Through him the services of John A. Roebling were secured as Engineer of the bridge. From that moment the engineering success of the structure was assured.

It is a well-established fact that to the genius of Roebling as an engineer, and to that of Kingsley as a builder, are directly traceable the successful construction of the bridge.

John A. Roebling met his death in the performance of his duty, and his son, Washington A. Roebling, was appointed as a worthy successor of his father, and, though prostrated for months by an illness contracted in the work, directed the construction to the end.

On May 24th, 1883, the bridge was formally presented to the two cities. In that hour, all the difficulties which had beset his path, were forgotten by William C. Kingsley in the supreme vindication which was his, in the enduring monument which was to ever after stand attesting the triumph of his genius and fortitude.

Having completed his work as builder, Mr. Kingsley tendered his resignation as a Trustee, which was accepted with the deepest sorrow by his coadjutors, who honored and loved him.

Mr. Kingsley was a man of imposing stature and figure, and, wherever he appeared, at once commanded respectful attention. Modest to a degree, he never sought nor toiled for fame.

In politics he was a Democrat, and many a campaign victory could be directly traced to his magnificent skill in organizing party forces. Mr. Kingsley, though importuned again and again to fill very responsible and honorable offices, never did so, but was content to wield his influence in a way best calculated to advance the interests of the country and community.

He was elected a Fellow of the American Society of Civil Engineers on June 6th, 1870.

His death occurred on February 21st, 1885, after a week's illness, with pneumonia and peritonitis. The entire city mourned the loss of a citizen who had served it with all the forces he could command, in a path of unswerving integrity.

FREDERICK W. MERZ, F. Am. Soc. C. E.*

DIED DECEMBER 8TH, 1883.

Frederick W. Merz was born in Germany in 1832, and came to this country about 1850. He was a mechanic in Louisville and opened a shop there for making architectural ironwork and doing general blacksmithing. His early work was on a small scale, and his financial resources were evidently not large, for his first anvil, weighing 140 lbs., he carried on his shoulders from the store where it was purchased to his shop, four or five blocks distant. In the course of time his business grew steadily; by 1870 he had a shop employing about a hundred hands and did a fair share of the architectural ironwork in and near Louisville, Ky. Later on, the business was incorporated, and Mr. Thomas J. Wood was associated with him. He acquired considerable property, and withdrew from his Louisville business four or five years before his death. He went to New York and there lost nearly all his estate, which so preyed on him that he became insane. He was in an asylum in New York for a time, but recovered and went to Louisville. He was attacked a second time, late in 1883, and died at the Central Kentucky Asylum for the Insane, at Lakeland, on December 8th, 1883, of paralysis.

Mr. Merz was elected a Fellow of the American Society of Civil Engineers on May 28th, 1872.

* Memoir prepared from information furnished by W. B. Belknap, F. Am. Soc. C. E.

MCREE SWIFT, F. Am. Soc. C. E.*

DIED APRIL 5TH, 1896.

McRee Swift was born in New York City, April 19th, 1819. He was the son of General Joseph G. Swift, the first graduate of the United States Military Academy and formerly Chief of Engineers, United States Army, and Louisa M. Walker, daughter of James Walker, a rice planter of Wilmington, N. C.

After spending nearly a year at college, he was appointed in 1836 a junior assistant on the surveys of the Long Island Railroad, under General W. G. McNeill, Chief Engineer, and James P. Kirkwood, Past-President Am. Soc. C. E., Resident Engineer. Later in the same year he went to Fort Caswell, N. C., where he pursued professional studies under the direction of his brother, Alexander J. Swift, of the Corps of Engineers, United States Army. The next six years he spent in railway engineering in New England. He was engaged on the surveys and construction of the Boston and Albany (Western) Railroad under Major W. Whistler, Chief Engineer, and Captains William H. Swift and John Childe, Resident Engineers. Subsequently he served as Assistant Engineer under Frederick Harbach, Chief Engineer, on the surveys and construction of the Pittsfield and North Adams Railroad, and the extension of the New Haven and Hartford Railroad to Springfield, Mass.

In 1843 Mr. Swift was appointed to a more responsible position, that of Superintending Engineer of the Wilmington and Raleigh Railroad, extending from the Roanoke River to Wilmington, N. C., a distance of 160 miles. While connected with this company he began to substitute the T-rail for the old plate rail in general use at that time on southern railroads. In 1846 he came North to accept the position of Superintending Engineer of surveys and construction of the Newburgh branch of the New York and Erie Railroad under Major T. S. Brown, Chief Engineer, and served at the same time as commissioner for purchasing land for right of way. In 1849 and 1850 he was Superintending Engineer of the surveys and construction of 70 miles of the New York and Erie Railroad, from a point west of and near Hornellsville, N. Y., to a point below Olean, N. Y. Horatio Allen, Past-President Am. Soc. C. E., was Consulting Engineer for this work. In 1851 he was Chief Engineer of the surveys for the Rochester and Genesee Valley Railroad.

Mr. Swift went to Europe in 1851 with his father, and spent a year in traveling there. On his return he became Chief Engineer of the surveys and construction of the Rochester and Genesee Valley, and

* Memoir prepared from information furnished by his family and from papers on file at the House of the Society.

the Avon, Geneseo and Mount Morris Railroads. This work engaged his attention until 1856, when he became Engineer and Superintendent of a manufacturing and constructing company, of which he was subsequently elected President.

In 1874 Mr. Swift was elected a member of the Commission on Streets and Sewers of New Brunswick, N. J., and served as President of the Commission for eight years, when he resigned.

Mr. Swift's career was that of an able, upright and successful engineer during the infancy of the profession in this country, but, except to the few professional contemporaries who survive him, he has been best known as a man of affairs and a public-spirited citizen.

His relations, friends, and all who have been associated with him in the many business interests with which he was connected, benefited greatly by his example and his advice, based upon a keen intelligence, generosity and unswerving integrity, never to be forgotten by those who knew him.

The rare cultivation of mind and the manner and presence, which rendered him a typical gentleman of the old school, were combined with business ability of the first order.

All who knew him were benefited by his acquaintance and example, and will remember him as a type of what a Christian gentleman and loyal friend and fellow-citizen should be and can be, and yet consistently achieve success in a professional and business career.

Mr. Swift was the twenty-third member of the American Society of Civil Engineers. His name is among those on the original list of names proposed by the Board of Direction of the American Society of Civil Engineers and Architects, preserved in the Society House, and his membership dated from November 6th, 1852. He became a Fellow of the Society on March 9th, 1870. In 1888 he resigned from active membership, but he retained his interest in the Society to the last, and in a codicil to his will, drawn up a short time before his death, bequeathed the sum of \$1 000 to the Society, the income to be devoted to the purchase of rare books and maps for its library and models for its museum. This gift was made in memory of his father, General Joseph G. Swift, who was chief engineer of many undertakings after his resignation from the army, among them the New Orleans and Pontchartrain Railroad in 1829, and the Harlem Railroad in 1832.



